

**Developmental Analysis of Young
Gymnasts' Understanding of Sport-Related Pain**

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by

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Abstract

Pain in sport serves the adaptive functions of signalling impending or actual injury and signalling the achievement of optimum workload to produce a conditioning effect. It is important to be able to distinguish what pain is signalling in order to respond to it effectively. The different functions of pain present a challenge for athletes wanting to improve their skill and conditioning level in the most efficient manner without becoming injured. However, this challenge could prove dangerous to children who have only a partial understanding of the value of pain, or who believe that they must endure great amounts of pain in order to become successful in sport.

Previous research with general populations has demonstrated that children have a naive understanding of pain causation and do not understand the value of pain. In addition, previous research demonstrated that social factors such as peer and parental pressure may lead to situations where child athletes suffer preventable injuries because they ignore the warning signals of pain.

Because coaches and parents are often responsible for deciding what to do when children present with pain, it is important for these adults to be aware of the cognitive limitations of children regarding the causes and meaning of pain. To date, there is no research which examines what athletes know about sport-related pain.

Participants for this research project were 68 gymnasts aged 6 to 13 years. Several questions were asked in this study: (a) can gymnasts of various ages distinguish different types of sport-related pain?; (b) do gymnasts respond differently to different types of sport-related pain?; (c) what reasons do gymnasts give for

continuing or discontinuing gymnastics when they have pain?; (d) do gymnasts understand the concept of pain causality?; (e) do gymnasts understand the value of pain?; (f) do gymnasts use pain for secondary gain? These questions were investigated in the context of an interview designed for this study. Two subtests from the Stanford-Binet Intelligence Scale and tests of cognitive developmental level based on Piagetian theory were also administered.

The effects of age, gender, level of cognitive development, experience with sport, and experience with pain and injury were examined for their influence on responses to the above questions. Results revealed age differences in the gymnasts' ability to distinguish types of pain such that older gymnasts identified more pain types. However, even the youngest participants were able to discuss more than one type of pain.

There were age differences in gymnasts' understanding of pain causality. Contrary to previous research demonstrating children to be unable to identify a physiological cause of pain, 32% of the gymnasts aged 9 to 13 were able to describe the role of the brain and/or nerves in pain causality. Also contrary to previous research with general populations, the gymnasts were able to discuss the value of pain, especially as a signal of hard work and as a warning to stop what they are doing. Forty percent of participants reported using pain (sport-related and/or non sport-related) for secondary gain. Not a single gymnast reported using pain as an excuse for a poor performance. Six of them did, however, report pretending to be in pain to avoid something in the gym that caused them fear.

Further demonstrating an appreciation of different types of pain, results

showed the gymnasts to respond differently to various pain types. These young athletes demonstrated an awareness of the need to stop their sport in some cases and to continue gymnastics in other cases, depending upon the type of pain. When continuing gymnastics despite pain, participants usually justified their decision by saying that the pain was not harmful to them. When describing why they discontinued gymnastics because of pain, participants often stated that the pain or injury may worsen. Few participants stated a concern for their future functioning. No participant described pressure from coaches, parents or peers to continue gymnastics while experiencing pain.

Results are discussed in a variety of contexts: (a) comparison of these results to those of similar research done with general populations of children; (b) implications for training practices, coach and athlete education, and sport policy in general; (c) support for a theory of cognition that encompasses both nativist and constructivist components; and (d) directions for future research.

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List of Abbreviations

APQ	Athletic Pain Questionnaire
KIT	Concept Assessment Kit
RAPI	Response to Athletic Pain Interview
SB Score	Stanford Binet Score
VAS	Visual Analogue Scale

Glossary

Abstract reasoning	The ability to think beyond concrete circumstances and consider intangible possibilities.
Causality	The relation of cause and effect.
Cognitive development	Changes in knowledge.
Disability	When an individual is no longer able to perform everyday activities.
Domain specific	A cognitive theory wherein each subject area has its own specialized way of thinking.
Functionalist	An approach to describe how children acquire knowledge through experience.
Haddon Matrix	A table with 'Factors Contributing to Injury' on the vertical axis and 'Stage of Injury' on the horizontal axis enabling the user to select cells in planning injury prevention strategies.
Handicap	Social disadvantage as the result of a disability.
Horizontal Décalage	Term applied by Jean Piaget to the observation that children's understanding of related problems did not always develop at the same time.
Injury	Physical damage to the body.
Pain descriptor	The term used to describe a painful sensation.
Secondary gain	Rewards obtained from the result of a negative experience.
Visual Analogue Scale	(VAS) Instrument used by an individual to quantitatively rate subjective experiences such as pain and anxiety.

Developmental Analysis Of Young Gymnasts' Understanding Of Sport-Related Pain

It has often been suggested that athletes must endure pain in order to succeed in their sport and make it to the top professionally (Danielson, Salmela, Proteau & Régnier, 1978; Guyot, 1991; Hall & Davies, 1991; Scott & Gijssbers, 1981; Spink, 1988; Stamford, 1987). Some people may reason, therefore, that athletes who compete at the elite level are less sensitive to pain than athletes who do not achieve this level. In this vein, pain insensitivity is regarded as an ability, one that is needed to succeed in sport. However, athletes spontaneously use pain control techniques (Hall & Davies, 1991; Morgan, 1978) and coaches and athletes often use phrases like "ignore the pain" and "push past the pain barrier" (Danielson et al., 1978) as a form of encouragement. These phrases indicate that athletes really do experience pain, but somehow get through it. It would seem that athletes are not insensitive to pain, but are able to tolerate more of it. If this is the case, then pain control could be viewed as a cognitive skill (Gauron & Bowers, 1986), with some athletes possessing a greater ability to function with pain than others (Meyers, Bourgeois, Stewart & LeUnes, 1992). The ability to tolerate pain may be the result of training and practice with coping techniques, or it may be a natural skill which serves to pre-select elite athletes.

Many children are involved in sport on a daily basis, often training to the point of experiencing pain. Although intense training is required in order to succeed

at any sport, it is not known at exactly what point the physical stress switches from being beneficial to being harmful to the athlete (Caine and Lindner, 1991). The difficulty in determining how hard to train, combined with a young child's immature understanding of pain and what it signals (Gaffney, 1993), may lead to many instances of continuing to train despite painful injuries which may lead to lifelong disability. It is therefore important to determine what athletes of various ages understand about the relationship pain has with both enhanced conditioning and with injury.

Pain In Sport

Functions of Pain

The literature on sport-related pain does not adequately define the term "pain;" therefore, it is not always clear what athletes are tolerating when authors refer to pain tolerance. The experience of pain can be confusing for athletes because it serves multiple distinct purposes. First, pain can signal an impending injury (warning pain). Second, pain can signal an actual injury (injury pain). In either of these cases, pain tells athletes that something may be wrong and that they should attend to the problem. However, pain which is caused by the by-products of exertion, such as lactic acid build-up, often serves a third and very different function of informing athletes that peak workload has been achieved and that their efforts have been adequate to derive benefit from their workout (training pain). After a basic level of fitness has been achieved, fatiguing and often painful effort is required in order to improve performance (Stamford, 1987). By signalling that gains are being made, pain can be satisfying to the highly motivated athlete. There exists, however, a fine line between pain which signals peak training effect and pain which signals potential damage or actual injury (Caine and Lindner, 1991).

Relationship Between Pain and Injury

It is possible to have pain without discernible injury (chronic pain) and injury without pain (Melzack & Wall, 1986). In the first case, sufferers are left with little recourse for addressing the pain. Although many people undergo multiple

treatments and surgery for such pain, learning to cope with the pain is the most useful form of treatment. People who do not feel pain in response to an injury, on the other hand, are at risk for serious injury, and possibly death, as they do not have the benefit of the warning value of pain. Thus, pain is a valuable warning that there is something wrong with the body.

The relationship between pain and injury is a complex one since there are at least three dimensions which influence the pain experience. These three dimensions have been termed the sensory or discriminative dimension, the motivational or affective dimension, and the cognitive or evaluative dimension (Melzack, 1973). The sensory/discriminative dimension involves the ability to sense pain and to discriminate it from other sensations. Athletes must be able to sense pain in order to heed the warning signal it may be sending and must be able to discriminate between types of pain in order to respond appropriately to each type. The affective/motivational dimension of the pain experience is relatively independent of the sensory/discriminative dimension. The intensity of the pain may or may not be related to how a person rates the unpleasantness of the pain. The emotional/affective dimension can be affected by the meaning of the situation to the individual. This phenomenon is reflected in the statements of gymnasts who say that pain feels worse following a poor performance and may be unnoticed following a successful performance (Snyder, 1990). The often observed discrepancy between actual tissue damage and pain behavior is the result of how an individual evaluates the pain experience. If the pain event is viewed as desirable, pain behavior is much less than if the pain is undesirable. This may explain why athletes are willing to

tolerate great amounts of pain while training: they may believe that such pain is necessary in order to make gains in conditioning and skill levels. It may also explain why some athletes tolerate great amounts of pain from their injuries: they may believe that playing through pain is what professional athletes, and they themselves, must do in order to succeed in sport.

The multi-dimensional view of pain is important to the study of sport-related pain for a number of reasons. First, the meaning attached to pain is likely to determine what athletes do about their pain. If pain is seen as a desirable sensation which indicates that the athlete has trained sufficiently hard to achieve some improvement, it will be sought after and tolerated. However, if pain is seen as an undesirable sensation associated with severe injury, pain may not be tolerated. The situation in which pain occurs will also influence athletes' response to it. A swimmer who has just won the national title is not as likely to notice a painful shoulder as one who has just lost.

Athletes and Pain Tolerance

Deciding how much pain can or should be endured for the sake of improved performance may not be a simple task. There have been no studies to date which address the process of *deciding* whether or not to play through pain. Athletes probably learn this from trial and error and by "tuning in" to their bodies (Thornton, 1990). However, this suggests that an athlete may have to actually suffer injury before learning to avoid crossing the "fine line" to injury. This ambiguity is especially dangerous for children, whose bodies are in a vulnerable state due to their immature bone and muscle development (American Academy of Pediatrics, 1983;

Anderson, 1991; Apple, 1985).

It is not uncommon to hear of athletes playing with broken limbs or severe injuries, or using pain-killers as a way to make it through their event. Such stories have led to the development of a myth that elite athletes are somehow insensitive to pain and must continue to play despite severe injuries, characteristics which children and adolescents may attempt to imitate. In fact, athletes do not deny the severity of their injuries (Smith, Scott, O'Fallon & Young, 1990). Further, accuracy in estimating disruption to everyday activities due to injury has been found to correlate with higher levels of athletic achievement (Crossman & Jamieson, 1985), and professional athletes have been observed to be quite sensitive to the warnings pain sends (Thornton, 1990). Disregarding warning and injury pain would reflect abuse of the body, which would inhibit the development of increased stamina and strength necessary for athletic improvement. However, when pain tolerance has been assessed using cold pressor and ischemic pain, athletes have been found to possess higher tolerance levels than non-athletes (Jaremko, Silbert & Mann, 1981; Ryan & Kovacic, 1966; Scott & Gijssbers, 1981; Walker, 1971). Further, contact athletes have been found to be more tolerant of experimental pain than athletes in non-contact sports (Ryan & Kovacic, 1966) and elite swimmers have been shown to be more tolerant of experimental pain than club or recreational swimmers (Scott & Gijssbers, 1981). However, the pain thresholds of athletes and non-athletes compared in the above studies were not found to differ, except in one study where female athletes demonstrated higher pain thresholds (Jaremko et al., 1981).

Why do athletes tolerate more of what could be considered warning pain than

non-athletes? Based on the literature previously reviewed, one would expect athletes to heed the warnings of potentially damaging pain and escape from it in order to protect their bodies. However, it is possible that the athletes did not perceive the pain as having any potential for injury, so they were not afraid to accept the pain. Spontaneous use of coping strategies (Hall & Davies, 1991), social desirability, experience with pain, selection factors (Ryan & Kovacic, 1966) and type of pain stimulus (Jaremko et al., 1981) may account for observed differences in pain tolerance between subject groups.

Although pain tolerance may be a requirement for success in some sports, this does not mean that athletes must tolerate exorbitant amounts of pain. For example, Guyot (1991) compared the running statistics of 370 runners on the extent to which these runners push themselves to the point of pain on a regular basis when running. The results showed that "pain running" was not correlated with better running performance. The "pain runners," however, were more likely to continue to train despite poor health or injury, and to run when the weather conditions were hazardous to health or safety. Running through extreme pain, it seems, may correlate with a general disregard for personal health and safety and is not conducive to enhancing sport performance. However, it is not clear how "pain" was defined in this study. If pain referred to training pain, then the results are surprising given the evidence that this type of pain is necessary to improve performance (Stamford, 1987). However, if pain referred to a sensation signalling impending or actual injury, then the results fit with the findings that successful athletes are sensitive to the warnings pain sends to them (Thornton, 1990) and are able to estimate

accurately the severity of their injuries (Crossman & Jamieson, 1985).

Danielson et al. (1978) found no correlation between experimental pain tolerance and performance among top Canadian male gymnasts. Régnier and Salmela (1980) found that the age of provincial level male gymnasts, but not their performance, correlated with experimental pain tolerance. Athletes aged 16 to 17 years tolerated more experimental pain than younger or older athletes. It was hypothesized that boys in this age group may be more likely to endure pain in order to prove they possess "manly" traits (Régnier and Salmela, 1980). Since both of these studies used subjects which were homogeneous in terms of the level of overall performance they had achieved, it is impossible to conclude that better performance is not correlated with higher levels of pain endurance. Nonetheless, these two studies are important as they provide evidence that tolerance of extreme experimental pain does not differentiate successful from unsuccessful athletes within the same level of competence. However, it is not clear how the athletes viewed the pain, or if the 16- and 17-year-olds perceived the pain differently than those in the younger and older age groups.

Another factor thought to influence pain tolerance is the gender of the individual. There have been few studies which have investigated gender differences in pain tolerance among athletes. Jaremko et al. (1981) found female athletes to have higher tolerance for pain from sphygmomanometer cuff pressure and cold pressor pain than male athletes and female and male non-athletes. This result was based primarily on the high rejection rate (55%) of female athletes from the study due to their reaching the ceiling during pre-tests of pain tolerance. The rejection

rate for male athletes was 29%, while 9% of female non-athletes and none of the male non-athletes were rejected. Hall and Davies (1991) found no differences in ratings of pain affect and pain intensity between female and male athletes during cold-pressor testing. Pain tolerance, unfortunately, was not reported.

Although age differences in pain tolerance have not been assessed within the athletic context, there is evidence from studies of general samples to suggest that younger children may have lower pain thresholds and report more pain than older children (Haslam, 1969; Lander & Fowler-Kerry, 1991). If younger athletes are quicker to detect pain, then they may also make more pain complaints than older athletes. On the other hand, many studies have shown children to tolerate pain better than adults (P. J. McGrath & Unruh, 1987). However, increased pain tolerance does not imply decreased experience of pain. It may be that children are better at distracting themselves from the pain than adults, or have not learned that making pain complaints may lead to positive reinforcement. Based on these studies of general populations, then, it can be expected that age of the athlete will have some effect on response to pain. Younger athletes may report more painful experiences, but may report greater tolerance to pain than older athletes.

Summary. The above studies provide evidence that athletes tolerate more pain than do non-athletes. Level of competition is an important factor, with elite athletes tolerating more pain than those at lower levels. However, athletes do not differ from non-athletes in their sensitivity to pain. Although one study reported sex differences in pain tolerance, there is not sufficient evidence available to make any conclusions in this area. There are a number of methodological problems within the

studies reviewed above, which will be discussed in a separate section. A major problem is the absence of a definition of pain in these studies and a failure to assess how the athletes perceived the stimulus meant to be painful. Social pressure appears to be one important factor influencing tolerance of pain.

Social Factors and Pain Tolerance

Although athletes presumably tolerate pain in an effort to improve their conditioning and skill levels (Caine & Lindner, 1991; Stamford, 1987) their decisions are often influenced by at least three social sources: peers, parents, and coaches. Sometimes these influences may be experienced as coercive.

Snyder (1990) described cases of peer pressure to take chances which may have led to severe injuries in gymnastics. Gymnasts who took chances with risky moves were referred to by their peers as "gutsy" and those who were less adventurous were called "chickens" (Snyder, 1990). This type of pressure from teammates has potential to lead to substantial injury for young athletes who may not have the cognitive ability to weigh the risks of the action to be performed (Thornton, 1990) or who believe that risks must be taken in order to succeed in sport. Snyder (1990) surmised that older athletes may be more cautious in their training after seeing teammates suffer severe injuries and then making a connection between personal injury and their own future. As athletes gain experience in a given sport, it is possible that they also learn that tolerance for extreme pain does not lead to enhanced performance.

There is evidence to suggest that the norms for ignoring pain may be more important than either experience with pain or previous social reinforcement for

ignoring pain as postulated by Ryan and Kovacic (1966). Johnston and Mannell (1980) used a non-athletic sample to demonstrate that individuals tolerated more pain if norms for this behavior had been established with a teammate and if that teammate was present during the assessment of tolerance. If the norms were not established, or if pain tolerance was assessed without the teammate present, the subjects did not increase their tolerance for pain. The implication of these results is that greater amounts of pain may be tolerated if the context for this behavior is present. Johnston and Mannell (1980) provide evidence that athletes may be responding to norms for pain tolerance in the same way a non-athletic sample would, that is, responding to a group membership effect (Lambert, Libman & Poser, 1960).

The mere presence of others may be enough to increase pain tolerance in young children. Results of a study using a cold pressor test (Lord and Kozar, 1989) suggest that grade two and three children may endure more pain when an audience is present than when they are alone. Although this study suffers from some methodological flaws, and its conclusions may not be as strong as the authors suggest, it provides evidence that children may report less pain in the presence of an audience. The authors suggest that an audience consisting of coaches and parents would exert even more pressure upon a child athlete to tolerate pain (Lord and Kozar, 1989). In addition, children with low self-esteem may be especially vulnerable to coach and parental pressure (Smith & Smoll, 1991). Lord and Kozar (1989) interpreted the effects of the audience as exerting pressure upon the children to endure pain, but it may be that the children felt safer among other people than

when alone and therefore felt more secure in accepting the stimulus.

The influence of young athletes' parents cannot be ignored where pain and injuries are concerned. The pressure to compete placed on young athletes by parents is often considerable (American Academy of Pediatrics, 1983) and sometimes reflects parental psychopathology (see Thornton, 1991 for an example). Children often feel compelled to participate in sport due to their parents' urging. The pressure from the parents, combined with young children's inability to connect pain with physiological damage, may lead to a severe injury. Such cases have appeared in recent media reports.

Athletes may also be reluctant to reveal their pain because they do not want to reveal their weaknesses to their opponents. Harrison (1992) reported that many wrestlers block out their injuries and focus on their match so as not to let their opponents know they are injured in a particular area. Hiding vulnerabilities puts the athlete at great risk for further injury to the same area.

There is also evidence to suggest that, rather than ignoring pain and injury, young athletes sometimes use pain complaints for secondary gains. Secondary gain from pain usually involves attention and sympathy from others, but can also have more important payoffs. For example, an injury can account for poor performance (Snyder, 1990) and may allow children to quit sports that are no longer enjoyable but are insisted upon by a parent (Nash, 1987; Thornton, 1991). There is also evidence to suggest that children may develop psychosomatic symptoms as a way to avoid participating in sport where the parents are more competitive than the children (Adler, Bongar & Katz, 1982).

Summary. The above data reveal that athletes are not less sensitive to pain than non-athletes, but that they are more tolerant of pain. This increased tolerance could be due to any of at least eight factors: (a) having less fear of the pain due to their experience with pain; (b) their spontaneous use of coping strategies, which may be a learned behavior; (c) the presence of a norm for pain tolerance; (d) the desire to demonstrate socially accepted behavior; (e) their desire to improve their skill or level of conditioning; (f) their motivation to win; (g) pressure from coaches, peers and parents; (h) wanting to hide weaknesses from opponents.

It is apparent that pain from fatiguing training and some training techniques may be an inevitable part of achieving elite status in many sports. However, an athlete does not have to train and compete with severe injuries in order to be successful (Guyot, 1991). The challenge for the athlete, then, is to distinguish accurately between pain which is indicative of achieving optimal training effects and pain which signals actual or impending injury.

Methodological Issues

Problems with previous research. The research discussed above concerning pain tolerance and social factors in pain tolerance suffers from a number of methodological flaws. First, the instruments used to produce pain, such as sphygmomanometer cuff pressure and cold pressor apparatus, may not produce sensations that are similar to the pain experienced while participating in sport. The cold pressor may actually elicit sensations which are similar to those experienced when athletes use ice packs to control pain and swelling (Jaremko et al., 1981). Second, the subjects in these studies may not have perceived the laboratory setting

as analogous to the sport context and, therefore, may not have responded in the same manner as when engaged in sport. Experimental pain requires little psychological involvement and does not elicit suffering on the part of the subject; in sharp contrast, clinical pain has important implications for individuals' health or safety (Wolff, 1986). Third, the subjects may have felt secure in enduring the laboratory induced pain because they believed that the researchers would not allow the pain to continue to a dangerous level. Fourth, experimental pain is of shorter duration and lower intensity than that of clinical pain (Wolff, 1986). Fifth, many studies did not control for, or did not report, the sex of the experimenter. This factor may lead to increased or decreased pain tolerance depending upon the combination of the sexes of the experimenter and the subjects. For example, using female experimenters to assess pain tolerance in males may lead to more competition among the males, with the result being higher pain tolerance (Jaremko et al., 1981). Sixth, the Lord and Kozar (1989) study examining pain tolerance in the presence of others introduced a confound by having future subjects watch while the experiment was carried out on other subjects. This study also compared adults from physical education classes, who may have more experience with pain than those not in physical education, to children who were not necessarily athletic. Seventh, each study discussed above involved subjects from only certain sports, and, therefore, the results may not be generalizable to all athletes.

The studies discussed above have not addressed separately the distinct concepts of pain and injury. It is clear that pain may not always indicate an injury, and athletes who experience an "unpleasant sensation" such as lactic acid build-up

may not label that experience as painful. In addition, athletes may have an injury without experiencing pain. It is important to understand what athletes understand "pain" and "injury" to mean.

Sport Injuries

Overview

Injuries in the context of sport are frequent (Koehncke, 1992). Children are especially vulnerable to sport-related injuries for a number of reasons, ranging from their immature bone and muscle development (Apple, 1985) to their inexperience in determining what the sensation of pain may be signalling to them (Gaffney and Dunne, 1987). If athletes are able to judge when their pain signifies the need to rest, to change activities, to warm up properly, or to seek medical attention, potentially severe and chronically disabling injuries may be prevented. This section presents epidemiological data concerning injuries in sport and provides evidence that these injuries lead to substantial health care costs. The section ends with a discussion of the reasons why children are particularly vulnerable to sport-related injuries.

Epidemiology of Athletic Injury

Data gathered by the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) reveal developmental trends in sport injuries (Ellison & Mackenzie, 1993). These data are gathered on an ongoing basis from the emergency services of 10 pediatric hospitals and 3 general hospitals in Canada. The category of "sports" accounts for 20.8% of all emergency visits for 5- to 19-year-olds. This figure peaks during the teenage years: for children between the ages of

15 and 19 years, 62.7% of all emergency visits are due to injuries from sport.

Data from the USA reveal that between 1979 and 1982 in Massachusetts, sport-related injuries were the leading cause of emergency room treatment in children aged 12- to 17-years. Over 30 percent of the injuries among 13-year-olds during those years were attributed to sport (Baker, O'Neill, Ginsburg & Li, 1992).

During the 1989 Jeux Canada Games in Saskatoon, 8,015 medical consultations were handled over the two week period (Harrison, 1992). Overall injury rate per 100 athletes was 29.7, which amounted to 3.44 injuries for every 100 hours of exposure for the 2,855 athletes. The 1985 Junior Olympics in the USA attracted 3028 participants and resulted in 1113 medical encounters during the seven days of competition (Martin, Yesalis, Foster & Albright, 1987). There were 718 athletes, or one in every four, requiring treatment. Some athletes were treated more than once, resulting in an injury rate of 39 per 100 participants.

When left untreated, seemingly minor injuries can lead to severe and chronic impairment (Micheli, 1984). Moreover, long-term negative consequences can result both from accidental injury and from overuse or repetitive strain. While the latter type of injury used to be seen only in adults, more and more children are now presenting with them (Micheli, 1986). The trend of children presenting with repetitive strain injuries may be due to the increased emphasis placed on competitive sport. This emphasis has resulted in a greater number of organized sporting bodies for children which tend to demand more training time from the athlete compared to non-organized sport (Backx, Beijer, Bol & Erich, 1991) and the use of systematic repetitive activities to teach and strengthen skills (Micheli, 1986).

Harrison (1992) notes that many athletes come to competition with chronic injuries that have been sustained during the course of training. For example, of 399 sport injuries studied over a 7 month period, 36% involved a body part that had been injured at least once before (Backx et al., 1991). Of the 121 significant injuries (those causing the athlete to be withheld from competition) attended to at the 1985 Junior Olympics, 26% were to body sites that had been injured prior to the meet (Martin et al., 1987). There were 115 athletes at the Junior Olympics who had sustained a previous injury that, due to its recency or severity, had potential to affect performance at the competition. Of these 115 athletes, 28% of them subsequently did sustain an injury during the games. Only 3% of the athletes not reporting prior injuries received medical attention. Because chronic ailments can result in emergency situations during competition, an emphasis should be placed on the prevention of such injuries (Harrison, 1992).

Costs of Sport Injuries

There is no doubt that individuals who participate in sport are more susceptible to injuries than those who do not (American Academy of Pediatrics, 1983; Baker et al., 1992; Harder & Seliske, 1993; Micheli, 1984). According to Statistics Canada (1991) 25% of all emergency ward cases are related to sport injury and the economic costs of sport and recreation injuries in Canada have been estimated at over \$633 million per year. The report on *Injuries in Saskatchewan* (Harder and Seliske, 1993) reveals that injuries accounted for a substantial proportion of health care costs in that province between 1979 and 1988. The authors of the report on *Injuries in Saskatchewan* urge public health agencies to give

a higher priority to the prevention of injury.

Haddon (1980) has proposed that injuries may be prevented by intervening in one or more cells of the "Haddon matrix." Koehncke (1992) reports on the use of such a matrix in order to reduce sport-related injuries through improved design and maintenance of sport facilities. The four factors considered at each of the three stages were: attitudes and behaviors of participants, quality of supervision, equipment, and facilities. See Table 2.1 for an example of a matrix pertinent to this dissertation research. This research was designed to discover information regarding participant behavior at the pre-event stage.

Research which aims to complete the Haddon matrix on injury prevention, especially in the cells designed to address the social and physical environment, was deemed especially important by the report on *Injuries in Saskatchewan*. Further, one goal of the World Health Organization is to substantially reduce the extent and severity of injuries in sport (Backx et al., 1991). Backx et al. (1991) report that studies concerning sports injuries in young adults rarely address the issue of injury prevention. Instead, research has focused on determining which sports pose a high risk for injury and identifying the etiology of these injuries, and on discovering the best methods of treatment and rehabilitation for athletes. The latter focus on treatment and rehabilitation is secondary prevention, as opposed to the primary prevention encouraged by Harder and Seliske (1993), Koehncke (1992), and this dissertation.

Table 2.1. Haddon matrix for addressing prevention of injuries in sport.

Factors contributing to injury	Stage of injury		
	Pre-event	Event	Post-event
Participant behaviors	Understanding of pain and injury and proper response to pain	Safe play and technique, behavior when in pain, obey rules	Behavior following injury, e.g., rest, ice seek health care
Supervisor behaviors	Knowledge of: dangerous aspects of sport; children's concepts of pain; safe play; first aid. Check equipment and playing surface/area, learn or plan for first aid	Rule enforcement, check equipment regularly, remind children about functions of pain	Able to administer first-aid or find alternative
Environment	Standards of personal and shared equipment, safe playing surface/area	Equipment and playing surface/area must endure activity	First-aid kit easily accessible, sport venue accessible to ambulance

Vulnerabilities of Child Athletes

Young children are said to be especially vulnerable to the effects of sport-related injury due to: (a) the immature development of their muscle, bone and connective tissue (Anderson, 1991; Apple, 1985; Committee on Sports Medicine, 1983; Lord and Kozar, 1989); (b) the difficulty they have in defining pain (Gaffney and Dunne, 1986; Harbeck and Peterson, 1992); (c) their inability to realize a link between pain and injury (Gaffney and Dunne, 1987), that in adults serves to limit potentially injurious activity or to prevent further injury; (d) their inexperience in judging when the pain they feel is harmful (Lord and Kozar, 1989); (e) a lack of interest in the proper fitting and care of protective equipment (Apple, 1985); and (f) a sense of immortality and invulnerability that prevents them from making long-term decisions (Thornton, 1990). The above problems, combined with the pressure to play from parents, coaches, and peers, and coaches' probable lack of education in assessment, treatment and prevention of injuries (Kenny, 1987; Weiss, Barber, Sisley & Ebbeck, 1991), may result in cases where children continue to participate in sport despite potentially severe injuries.

Injury prevention in sport may occur partly through a better cognitive understanding of pain by athletes. Young athletes who are ignorant of the different types of sport-related pain and who do not know what to do when they experience pain, or those who believe warning and injury pain are a necessary part of training, run the risk of serious injury through repeated use of an injured body part. Although education alone is usually not effective in preventing general injuries (Pless & Arsenault, 1987), comprehensive programs combining both behavioral and

non-behavioral intervention strategies have been shown to reduce injuries (Gielen, 1992). It is likely, therefore, that sport-related injuries can be reduced by providing athletes with information regarding pain and injury prevention and instituting changes in training techniques and sport policy. Before this action can take place, however, it is important to understand what athletes of all ages know about pain and injury and what they are capable of learning. Athletes cannot make use of information they do not understand.

Children's Understanding of Pain and Injury

What and how children think has been studied by numerous investigators with numerous methods. The dissertation research presented here was designed to determine the stages children progress through in their cognitive understanding of pain in athletics. It was necessary, therefore, to examine the most well-documented of cognitive developmental stage theories, Piagetian cognitive development. There have been criticisms of this theory, and many current researchers are using an information processing approach to learn about children's thinking. Nonetheless, for reasons elaborated below, Piagetian methodology is most suited for the present study.

Piagetian Cognitive Development

In Piaget's model, children pass through an invariant series of stages of cognitive development which are loosely correlated with chronological age (Piaget & Inhelder, 1969). Cognitive development is seen as progressing from simple, concrete concepts or schemata to more complex, abstract ones. Most introductory

psychology or developmental psychology text books provide an overview of Piagetian theory (cf. Harris, 1993). The first stage of development, the sensorimotor stage, encompasses the period of birth to approximately 18 months. During this stage, infants learn to differentiate themselves from the rest of the world. The second stage encompasses the age range of approximately 18 months to 7 years and is labelled the preoperational or symbolic stage. During this stage, children begin to represent things using speech, play, gestures and mental pictures. The concrete operational stage, wherein children are aged about 7 to 11 years, represents a time during which children become capable of mental logic using manipulable objects. The final stage, labelled formal operations, includes children aged approximately 11 or 12 years and older. During this final stage, reasoning ability allows adolescents to become actively engaged in belief systems and ideas.

Children's ability to solve different problems was explained by Piaget as their acquiring new mental operations which allowed for a higher level of reasoning to occur. The water conservation task is an excellent example of how reasoning changes. This task involves pouring water from a short, wide glass into a tall, narrow glass and asking children to identify which glass has more water. Five-year-olds regularly say that the narrow glass has more water because the water level is higher. Eight-year-olds, on the other hand, will say that the amount remains the same due to the nature of the transformation from glass to glass, or to the fact that the operation is reversible, or will point to the differences between the shapes of the glasses. Although 5-year-olds will grant these facts, they do not recognize them to mean that the amount of water is the same in each glass (Siegler, 1986).

Children's reasoning in the preoperational stage is marked by the use of only one dimension for solving a problem (Inhelder & Piaget, 1958). For example, when predicting how far a ball will travel, children in the preoperational stage will consider only the strength with which the ball was thrown and not consider things like air resistance or the material with which the ball was constructed. Children in the formal operational stage, however, will make use of all existing data and consider all possibilities when solving problems. The ability to consider all possibilities allows individuals to plan their actions and interpret what happens within a total context. Younger children, however, are more likely to consider things on a case by case basis, which limits their planning ability and may lead to misinterpretations of events (Siegler, 1986).

Assumptions of Piagetian theory. Piaget believed that children develop qualitatively distinct levels of intelligence through the processes of assimilation, accommodation, and equilibration. These three terms refer to processes of transforming new information to fit with existing information, adapting to new experiences, and an interaction between current ways of thinking and new experience, respectively. Equilibration is the defining feature of development, as it reflects the increasing stability between the child's current cognitive system and the reality of the external world. The above processes emphasize the biological nature of Piaget's theory. Piaget was strongly influenced by Darwin, and saw cognitive development progress according to the rule of the "survival of the fittest" (Sutherland, 1992). Intelligence was an adaptation to environmental demands.

Piaget believed that cognitive development can occur only if there is

cognitive activity; children must actively construct reality. There is a reciprocal interaction between the mind and incoming information such that each transforms the other through the processes of assimilation, accommodation, and equilibration. Further, Piaget perceived children as "scientific problem solvers" in that they strive to make sense of the world through trial and error. When confronted with a challenging situation, children were assumed to engage in problem solving until satisfied that they have the correct grasp of particular concepts.

One further assumption lies in Piaget's methodology for studying children's thinking. In gathering data, Piaget made a choice to obtain information rich in content at the sacrifice of standardization. According to Siegler (1986), Piaget recognized the value of having children explain their reasoning and the opportunity this procedure would have for unexpected findings. Thus, Piaget was able to discover things that had not been found using standardized procedures. However, as will be discussed in the section concerning criticisms of Piaget's theory, this method also appears to have led Piaget to underestimate children's capabilities in some domains.

Implications of stage theory. There are at least four implications of Piaget's stage theory of cognitive development (Flavell, 1971). First, the changes children go through are qualitative in nature. Passing from one stage to the next is marked by a shift in the way children view and understand the world. An analogy for qualitative change is the development of a butterfly from a caterpillar. Quantitative change, on the other hand is analogous to the piece-by-piece construction of a building. The qualitative view of children's thinking has been controversial and it

may be more useful to view children's cognitive development as having both continuous and discontinuous aspects (Siegler, 1986). For example, when a child solves a problem one day which she or he was unable to solve the day before, the change seems quite sudden. However, it is likely that the child was slowly moving toward mastery of this problem for quite some time.

A second implication of stage theory is that children at a certain developmental stage use the same type of reasoning for all concepts. For example, children in the pre-operational stage use only pre-operational reasoning for understanding concepts and the shift to concrete operations results in them using a higher level of reasoning for these concepts. Thus, a child in concrete operations should be able to solve all problems requiring the conservation of number, weight, or liquid quantity, but be unable to solve problems requiring reasoning using several possibilities. This view of children's thinking is also controversial as children have been shown to display different levels of reasoning for related problems (Elkind, 1961). Piaget recognized the difference in children's understanding of related problems and termed the phenomenon "horizontal décalage." The phenomenon of décalage will be discussed further below.

A third implication is that the transition between stages is rather abrupt, separated only by a brief transition period. According to Siegler (1986), this idea has been disproved by evidence that children's thinking is continually changing and is marked by gradual rather than sudden change. Finally, stage theory implies that children's thinking is coherently structured, and research does support this view (Siegler, 1986).

Other theories of cognitive development. There are many theories which address the questions of what actually develops during cognitive change and how that development occurs. Piaget's theory, in a nutshell, holds that qualitatively distinct levels of intelligence develop through the processes of assimilation, accommodation, and equilibration. According to Siegler (1986), Piaget's answers to the questions of what develops and how are in the right direction, but require further refinement. The information-processing approaches have provided that refinement by focusing on how children think. Although these approaches have significantly advanced what we know about children's thinking, this dissertation research was not so concerned with *how* children think as with *what* they think. Therefore, Piaget's approach is much more highly suited to answer the question "What do young gymnasts understand about sport-related pain?". Asking how children acquire such knowledge is an entirely different question, and would probably require the use of an information-processing approach.

Criticisms of Piaget's theory. Piaget's theory has received a great deal of attention from researchers around the world (Halford, 1989). Many have claimed that Piaget's findings have been based on the responses of children who would have been successful on the experimental questions or tasks if the test items were presented in a different manner. In other words, some of Piaget's results were based on false-negatives. On the other hand, results obtained by Piaget's critics have often been based on false-positives, or an over-interpretation of their findings (see Halford, 1989, for a review). Another problem, according to Kuhn (1992), is that researchers after Piaget wrongly interpreted his work. The most important

aspect of Piaget's theory was the attempt to understand how children construct meaning from experiences in an effort to understand their interaction with the environment (Kuhn, 1992). Thus, environmental factors were given a vital role in cognitive development. North American developmental psychologists, however, emphasized the stage element of the theory and made the stages the central aspect of Piagetian theory (Kuhn, 1992). For example, in a review of the literature concerning Piagetian and neo-Piagetian research, Halford (1989) stated that the single feature which distinguishes Piagetian theory is its emphasis on internal and self-regulating structures, with the influence of the environment being minimal. This inaccurate interpretation of Piaget's theory was, of course, criticized by authors who found that not all cognitive abilities which comprise a developmental stage mature at the same rate.

More recent research has revealed that cognitive development is not the result of abrupt transitions from stage to stage and the concepts pertinent to each stage are not acquired concurrently (Brainerd, 1978; Flavell, 1971, 1982). That is, a child may develop one ability much before another, even though both abilities are characteristic of the same stage. As discussed above, Piaget himself noted that children able to solve conservation problems using mass could not always solve the same problem using volume. "Horizontal décalage" was the term Piaget gave to the sequential mastery of concepts within a particular developmental stage. However, Piaget did not explain this gap in development.

Décalage may occur because some tasks are more complex than others, and, hence, success on them develops at different rates (Cowan, 1978). However, task

difficulty is not the only factor responsible for *décalage*. Experience is a key factor in determining which tasks a child will successfully perform (Gelman & Baillargeon, 1983). Children who have some experience conserving water will perform at a higher level on such a task than children without such experience.

It is important to note that some individuals never reach the stage of formal operational thinking, even as adults. For example, Papalia (1972) found that only 65% of subjects aged 21-30 years used formal operations in problem-solving. Again, experience with the relevant concepts is one thing which may influence the expression of formal operational thought (Harris, 1993).

The above criticisms do not indicate that Piaget's *method* of determining what children do and do not know was misguided. Indeed, research replicating Piaget's experiments has revealed that Piaget's methods were quite sound (Halford, 1989). However, one extremely important criticism concerns the discrepancy between what children are able to communicate about their thinking and behavior in a situation versus their actual thinking and behavior in that situation. There is ongoing debate as to what is more primary, language or thought (Sutherland, 1992). At one extreme, proponents of the primacy of language argue that a person's view of the world is limited by the language she or he has access to. Language is believed to influence the thoughts people have. Those in the middle argue that language and thought influence each other and aid in the development of each other. For example, children want to know the names of new things they encounter just as they want to know the meaning of new words they hear. At the other extreme, proponents of the primacy of thought argue that children's thinking is what develops

and is then followed by their use of language to describe their thinking. Piaget was a proponent of the primacy of thought as he recognized that children's language development lags behind the development of action. In addition, verbal communication proficiency has been shown to be significantly related to age (Kruass & Glucksberg, 1969). These findings indicate that young children may engage in behaviors for which they do not have the skills to verbally communicate what they are doing or why they are doing it. Thus, sampling young children's verbal responses is not a sample of their actual behavior and may not even reflect their actual thinking. For children who have reached a particular level of verbal ability, however, their verbal response can be taken as an accurate description of their behavior in various situations.

The debate concerning the primacy of language versus thought is important when it comes time to draw conclusions in a study. Proponents of the primacy of language would argue that children's thinking can be accurately sampled using children's verbal descriptions of their thinking. Proponents of the primacy of thinking, however, would argue that such studies underestimate children's thinking. The results from studies using verbal descriptions can only be interpreted as what children are able to verbally express. Whether this expression is an accurate account of children's thinking or not is part of an ongoing debate. What does seem clear is that studies using children's verbal descriptions of their behavior cannot make conclusions regarding young children's actual behavior. Such conclusions are better made by observational studies. However, for some types of research, including this dissertation, this limitation is not a serious one. In many cases, for

example sexual abuse cases or instances where a child needs medical attention, children's verbal reports are extremely important. Environmental consequences, such as counselling, legal investigation, or medical aid, result as a consequence of children's verbal reports and behavior, not as a result of their thought. The investigation of children's ability to communicate certain experiences to adults is, therefore, a valuable endeavour.

There is another important reason to determine what young athletes say they understand about sport-related pain. If intervention programs are to be developed to teach children about the various functions and implications of pain, it is important to determine what they already understand about this concept. It may be possible to accelerate the development of an understanding of a complex concept such as pain, but only if the instruction is not too far ahead of where the athlete currently functions. One way to discover what athletes know about pain is to ask them.

Importance of Piagetian theory. Much of the research reviewed above indicates that Piaget's methodology resulted in erroneous conclusions about children's thinking in many domains. However, his theory has much appeal for researchers and teachers for a number of reasons. Siegler (1986) provides four reasons for the longevity of Piaget's theory. First, Piaget's research provided a substantial explanation of what children's thinking is actually like. That is, his theory is intuitively appealing. Second, Piaget's theory provided a framework from which to examine many of the fundamental aspects of human intelligence, such as concepts of number, time, space, and causality. Third, the theory has great breadth in terms of both the ages and the concepts it encompasses, and describes how these

concepts are related to one another. Finally, Piaget was gifted when it came to making interesting observations of children's behavior. This gift allowed him to capture behaviors that others had overlooked using standardized methods.

Piaget investigated and documented much evidence of how children construct various aspects of their world. However, many of these concepts do not directly relate to this proposal and so will not be discussed. The concepts which do relate most directly to this proposal are those of understanding of causation, egocentrism, and abstract reasoning. The development of these concepts and their impact on children's thinking will be described below. In addition, the possibility of accelerating development will be briefly discussed.

Causality. In order to examine children's understanding of causality, Piaget (1930) used experiments concerning the following concepts: the nature of air; the origin of wind and breath; movement of clouds, planets and water currents; movement due to weight and force; floating of boats; the level of water; shadows; and machines such as bicycles and steam-engines. Piaget's experiments resulted in 17 distinct types of causal explanations which children and adolescents used during the development of their understanding of causality. These types were categorized within three main periods of development. The first period encompassed children within the pre-operational stage, the second, children in the stage of concrete operations, while the third phase included children from the stages of concrete and formal operations.

During the first period, children used motivation, phenomenistic, finalistic, and magical types of causal explanations (Piaget, 1930). This preoperational stage

reflected the use of concrete explanations and a focus on external perceptual events. There was often a focus on one single part of an event with no consideration of the whole. Explanations here reflected the ideas that dreams are sent to us because we have been bad, ducks have webbed feet so that they can swim, or that fire causes movement.

During the concrete operational period, artificialist, animistic, and dynamic explanations were used (Piaget, 1930). Children were now able to differentiate what was internal versus what was external to the self, although the focus on external real events remained. Children in the second stage explained an event based upon the intention behind it or based upon the understanding of clouds, mountains, and other things being alive and conscious. Dynamic explanations took over from animistic ones, and children understood events to occur based upon some force within the object.

During the period of formal operations, the early forms of explanation gradually disappeared and were replaced with explanations which were more rational. Children in the third stage examined evidence presented to them and used clues from the environment to help them formulate an understanding of the environment. They were able to hypothesize events when they did not have adequate information to make firm conclusions. Children also began to use their understanding of spatial relationships, mechanical causality, elementary chemistry such as condensation and atom composition, and logical deduction in their explanations to questions. Children aged 7 to 8 years were within this third period of development, and those aged 11 years and above had completed the cognitive

development of an understanding of causality (Piaget, 1930).

To summarize, the two outstanding characteristics of causality at the age of 4 or 5 years are an immediacy of relations and an absence of intermediaries (Piaget, 1930). For example, children in this early stage said pedals make the wheels of a bicycle move without accounting for the attachment of the pedals to other parts of the bicycle. It is simply the influence of the pedals that causes the movement. Children aged 11 to 12 years did not make the same kind of mistakes. Although children in this later age range may have had no idea how a car engine works, they were able to understand the necessity of intermediaries such as hoses and belts between fuel and the movement of various engine parts (Piaget, 1930). Younger children did not make such hypotheses.

Abstract reasoning. Piaget's studies of the reasoning ability of children aged 2 to 11 years demonstrated that children were unable to think simultaneously about several aspects of a single situation (Ginsburg & Oppenheimer, 1969). Children in this age range tended to engage in "syncretism," where they constructed confused wholes out of parts that do not belong together and in "juxtaposition," where they did not understand ordinal relationships. In addition, these children did not realize relations between a part and the whole of which it is a member. However, Piaget noted that these findings may only hold true when assessing children verbally, and do not necessarily reflect their actual behavior. As mentioned above, the development of language lags behind that of action and what the child learns at a younger age on the action domain must be reconstructed at a later age on the verbal domain (Ginsburg and Oppenheimer, 1969).

According to Piaget, great changes take place once children move beyond concrete operational thought. Formal operational thought is characterized by several new abilities, such as thinking in hypothetical terms, using propositional logic, and dealing with abstractions. Children who have reached formal operations are able to think beyond their present circumstances and consider other possibilities that are beyond concrete reach (Inhelder & Piaget, 1958). Children who have not reached the stage of formal operations are unable to engage in hypothesis testing and do not understand abstract concepts. The ability to think abstractly, or to grasp the "intangible characteristics of concepts" (Harris, 1993) appears around the ages of 10 to 12 years (Martarano, 1977). According to Harris (1993), children in the concrete stage of cognitive development have difficulty understanding abstract concepts such as freedom and courage because of their tendency to focus on specifics rather than on the general principles involved in these concepts.

Egocentrism. All children go through an egocentric stage where they have great difficulty taking a perspective other than their own. For example, children displaying egocentric thinking are unable to mentally rotate a display in order to guess how it would look to someone sitting in a different spot than themselves. This stage ends somewhere between the ages of 5 and 6 years. Until that time, however, children are overly attentive to their own perceptions and have difficulty communicating with others as they do not pay attention to what others are saying, and talk about whatever they wish to discuss.

Accelerating development. According to Siegler (1986), Piaget hedged when it came to stating whether cognitive development could be accelerated in children.

It appears that Piaget thought that training could be effective, but only if the child already possessed some understanding of the concept to be trained and if the training materials allowed for physical interaction. Researchers after Piaget have demonstrated that children can indeed learn complex concepts with a variety of instructional techniques.

Implications of Piagetian Theory for Children's Concepts of Pain

The evidence above demonstrates that children in the initial stages of an understanding of causality do not appreciate the connection between cause and effect. It is not until they reach the stage of formal operational thought that they are able to appreciate the role of intermediaries in the cause-effect relationship. Piaget did not examine children's understanding of pain. However, the evidence he gathered suggests that very young children, those in the preoperational and concrete operational stages, would describe pain as being caused by external events without acknowledging intermediaries. For example, pain may be caused by a hockey puck rather than by nerve damage. It is not until the third stage that children are able to understand the concept of an intermediary between cause and effect. Following Piaget's analysis, therefore, it can be predicted that a young hockey player in the third stage would understand that a hockey puck causes pain only through its impact on nerves in the body which then transmit a message to the brain. Therefore, a child in the third stage may appreciate the importance of medical attention and the necessity for allowing an injury to heal before resuming activity. A child in the first or second stage, however, may not understand the importance of reporting the pain to an adult or limiting activity during or following the experience of pain. In

addition, the concept of pain causality requires a rudimentary understanding of physiology, to which most children, and many adults, have not been exposed.

The evidence for children's reasoning abilities indicates that children between the ages of 2 and 11 years will have difficulty perceiving and discussing pain from more than one perspective (Ginsburg & Oppen, 1969). It is not until they reach the stage of formal operations that children are able to recognize and deal with abstract concepts, such as pain. As such, children in the stages of concrete operations and preoperational thought are likely to understand pain on only one dimension and respond to all types of pain in the same way, regardless of whether that behavior is adaptive. The present study is concerned with young athletes' ability to understand the intangible characteristics of the concept of pain. According to the above evidence, children who have not reached formal operations should have difficulty understanding the value of pain in a sporting context and the multiple functions of pain. They would be expected to talk about pain as a single "thing" that upsets them and be unable to distinguish between different types of pain which may be giving them very different and important messages. Older athletes, however, would be expected to use their reasoning ability to talk about pain from a variety of perspectives. These older athletes should also be able to distinguish two or more types of pain, and report responding differentially to the types. Since the ability to form hypotheses rather than relying solely on concrete evidence also appears during the stage of formal operations, it is likely that older athletes are able to speculate about the implications of pain, even if they have not experienced these implications. Younger athletes, on the other hand, are more likely to discuss only events which

have happened to them and be unable to speculate about other consequences of pain.

The concept of *décalage* suggests that athletes' understanding of pain may develop at a faster rate than their understanding of other concepts if they have had experience with pain. It may be possible, therefore, to have an athlete in the concrete stage of cognitive development for reasoning ability who has an understanding of sport-related pain which reflects formal operational thought. It is also possible to have athletes at different stages of development of causation, depending upon their experience with pain and injury. For example, the subjects in Papalia's (1972) experiment may have failed to engage in formal operational thought due to a lack of experience with the experimental apparatus or any structure similar to it. Likewise, children who have had little or no experience with sport-related pain may not realize the various functions of pain.

Children engaging in egocentric thought may have difficulty responding appropriately to questions aimed directly at establishing their understanding of pain. Such children may not pay attention to the interviewer and may instead discuss some other topic. This problem may not be so likely to occur when children are actually in pain, as their attention would be focused on themselves and their pain. However, since children who think egocentrically give inadequate descriptors of their observations, they may not be able to describe their pain in a way that is understood by others. They will have trouble explaining what happened to result in pain, or what their pain feels like, to another person. Since this type of information is often important to diagnosing and treating pain, children who are unable to describe these two pieces of information are at a disadvantage compared to those who can. The

experience of pain is difficult to describe, even for adults (Melzack & Wall, 1988), and it is important to know what children of different ages can say about their pain so that they receive optimal care from adults.

A Piagetian analysis of children's understanding of pain has implications for young athletes and those responsible for their well-being. It is important for coaches and parents to know what children of different ages are able to understand about pain and its potential implication for injury. Children in the pre-operational and concrete operational stages may not possess the cognitive skills required to differentiate between the types of pain experienced as accurately as children in the later formal operational stage do. Very young children may perceive all types of pain as signalling the same physiological event, and, therefore, may respond inappropriately to some types of pain.

Regardless of what children do understand about pain, it may be possible to improve this understanding through instruction. Therefore, identifying young athletes who need to learn more about the various functions of pain, and then teaching them the important concepts, may help them to make safer decisions regarding caring for their pain. Instruction, however, must proceed at a pace just slightly ahead of children's current level of understanding, as too large a jump may result in the child being unable to grasp the new concepts.

Research concerning children's understanding of pain was preceded by, and is in some cases based on, research on children's understanding of illness causation. In addition, children's understanding of illness has received more attention in the research literature. For these two reasons, evidence concerning children's

understanding of illness causation will be examined before the literature on children's understanding of pain is presented.

Children's Concept of Illness Causation

Some researchers studying children's understanding of medical illness and injury have proposed that children progress through a series of stages similar to the cognitive stages proposed by Piaget (Bibace & Walsh, 1979, 1980; Brewster, 1982; Perrin & Gerrity, 1981; Redpath & Rogers, 1984; Siegal, 1988). Bibace and Walsh (1979, 1980) have provided the most detailed explanation of their research methods and offer the most comprehensive data analysis of any of the studies. During the pilot phase of their research, Bibace and Walsh (1979) questioned children aged 3 to 13 years on their concept of illness. Their protocol was modeled after the questioning system of Piaget (1952) and Laurendeau and Pinard (1962) concerning causal thinking. This format of questioning was designed to elicit the quality of children's reasoning, rather than simple yes or no responses. For example, children were asked "What is a cold?" and "Why do people get colds?" and prompted for their answers. The data from these responses were classified in terms of the three latter stages of Piagetian development: preoperational, concrete operational, and formal operational. Bibace and Walsh did not assess the children's cognitive developmental level for concepts such as conservation or causality using any standard Piagetian tasks. The children's responses concerning illness causation were coded according to their fit within Piaget's developmental framework.

The preoperational explanations derived from the children in the study by Bibace and Walsh (1979) were classified in three ways: (a) "incomprehension" as

defined by an inability to respond effectively; (b) "phenomenism" where illness was described in terms of a single external symptom, such as a sight or a sound, associated with illness; (c) "contagion" where illness was explained based on spatial or temporal proximity between sources such as people, objects, or events and the illness. Once children entered the concrete operational stage of development, their responses began to reflect their ability to take the viewpoint of others and to focus on wholes rather than parts. There were two substages within concrete operations: (a) "contamination" wherein children added bad behavior to contact with dirt or germs as a cause of illness; (b) "internalization" where children described illness as being within the body.

As children enter the formal operational stage of cognitive development, their differentiation between self and the world increases and they are not so bound by concrete reality. During the "physiological" substage, children defined illness in terms of internal malfunctioning which manifested itself as external symptoms (Bibace & Walsh, 1979). Although an external event may trigger the cause of illness, the cause was now due to internal processes. The move away from concrete operations was clearly identified in the children's ability to entertain possibilities for causes and cures of illness which are not external or visible to them. Thus, the children were able to use hypotheses to explain the relationship between the body and the environment, rather than relying on concrete experience. In the final substage of understanding of illness causation, children acknowledged psychological causes that may affect the functioning of the body. In this "psychophysiological" substage, children still defined illness in terms of internal processes, but now

included psychological symptoms.

One major change demonstrated in the research of Bibace and Walsh (1979, 1980) was the change in perceived control over illness between children in the earlier versus later stages of cognitive understanding of illness. Increasing control was correlated with the shift from a phenomenistic to a psychophysiological explanation of illness. Initially, children perceived themselves to be vulnerable to a variety of external events that adults would deem irrelevant. As children entered the contagion stage, they felt vulnerable to fewer such events, as they recognized only events that are near to the body to cause illness. There was a qualitative shift when the children entered the contamination stage as the event now had to touch the surface of the body in order to cause illness. Children then believed they could avoid illness by staying away from contaminated surfaces. Once children entered the internalization phase, they began to realize that they were able to do things in order to maintain health, rather than simply try to avoid contamination. Eating healthy food, for example, was one way children believed they could stay healthy. Once children entered the physiological and psychophysiological stages, they were able to view illness as having multiple causes, and thus, multiple means of prevention. It is this connection between cause and control that is of importance in the context of sport. Pain may have multiple causes and may signal multiple events that are taking place within the body. Being able to differentiate types of pain and respond appropriately to them, especially warning and injury pain, are important skills for children to have in order to prevent serious injury in themselves. In addition, children who view pain as resulting from external events over which they

have no control may not take active measures to prevent pain or to seek help in alleviating the pain. Other research concerning children's understanding of illness will now be presented.

Perrin and Gerrity (1981) studied children in kindergarten and grades 2, 4, 6, and 8 for their understanding of illness causation. Included was an assessment of the concepts of conservation, transformation, interrelationships among parts, physical causality, and abstract thinking. Despite a wide range of response scores within each grade level, mean illness scores increased with grade level. The scores on the illness interview were highly correlated ($r = .81$) with the scores on the general cognitive interview. Concepts of illness causality were more closely related to concepts of physical causality than any of the other general concepts. However, illness causation concepts emerged at a later age than physical causality concepts. Mean scores for responses to physical causality questions were consistently higher than mean scores for responses to illness causality questions. This result indicates that, although an understanding of illness causality may parallel general cognitive development, it develops more slowly. This does not seem surprising considering that some knowledge of physiology was required in order for children to receive higher scores for their responses concerning illness causality.

Brewster (1982) examined the conceptions of chronically ill hospitalized children regarding the cause of their illness and their understanding of their prescribed treatment. Children aged 5 years to 12 years, 11 months were assessed using a variety of tasks and questions in order to determine their cognitive developmental level in each of the following five categories: conservation of matter

and volume, physical cause and effect, cause of illness, grasp of social role perspective, the intent of medical procedures and personnel. Results showed that all 5 tasks were positively correlated with each other and with the age of the children. The responses to questions concerning the cause of illness, the role of medical personnel, and the purpose of medical procedures fell into three major stages, with stage 3 being the most cognitively mature. These stages were, however, not absolute. For example, some 8-year-olds provided a stage 1 response while some 6-year-olds gave a stage 2 response.

Using kindergarten and grade 2 students, Redpath and Rogers (1984) investigated the effect of age, sex, and previous hospitalization experience on children's understanding of medical concepts. Children's cognitive developmental level was assessed using a conservation task and a physical causality question regarding the origin of night as used by Perrin and Gerrity (1981). Questions regarding medical concepts sought to elicit children's understanding of doctors, nurses, hospitals, operations, and illness. The kindergarten children were found to demonstrate less knowledge about medical concepts than did the second graders. Grade level was positively correlated with the medical concepts score, while gender was not. There was an interaction between grade level and hospitalization experience, such that grade two children with previous hospital experience scored higher on the medical concepts questions. Finally, medical concepts, conservation and causality were correlated with each other for the total sample of children. Within some of the grade groups, these correlations did not exist. For example, the medical concepts scores were significantly related to causality but not to

conservation for the kindergarten group, and there were no significant correlations for the second graders.

Simeonsson, Buckley and Monson (1979) appear to have produced research with more predictive and convergent validity than any of the studies already discussed. These researchers assessed 4- to 9-year-olds' receptive language using the Peabody Picture Vocabulary Test (Dunn, 1965), their developmental concept of conservation using The Concept Assessment Kit (Goldschmid & Bentler, 1968), their concept of causality using Piaget's (1930) question, "What makes clouds move?", their concept of illness causality using six questions, and their role-taking skills using a set of five cartoon drawings. Results were analyzed according to age and older children were found to provide more stage two and stage three developmental responses to four of the six illness questions. These results were interpreted to indicate that there were developmental differences in the children's concepts of illness causality and that some questions were more sensitive to developmental differences than others. Responses to the conservation and role-taking assessment also reflected developmental trends, whereas responses to the physical causality question did not. Mean scores from the illness causality questions were correlated with egocentrism, conservation, and chronological age. When the effect of chronological age was controlled for, illness causality scores correlated with scores of conservation, egocentrism, and physical causality. These results indicate that, although physical causality scores were not correlated with age, they were correlated with the development of a concept of illness causation.

Burbach and Peterson (1986) reached a number of important conclusions

after reviewing 11 studies concerning children's understanding of illness. Some of these studies used healthy children, some used ill children, and others used a combination of both. There were three major results of their review. First, there is a clear relationship between chronological age, cognitive developmental level, and understanding of illness. This relationship is best demonstrated by Bibace and Walsh (1979). Second, there is no effect of gender on the relationship between cognitive developmental level and illness concept. However, age-based research reveals that older males are more reluctant to acknowledge illness and pain than same-age females or younger children. Third, it is unclear what impact previous hospitalization experience has upon children's illness concepts.

Methodological problems. Research concerning children's concepts of illness is relatively new, the first study being published in 1978. Burbach and Peterson (1986) highlight five methodological shortcomings of the illness concept literature which future studies must address in order to produce valid results. Research concerning children's pain concepts must also address these areas. First, researchers must provide detailed descriptions of subjects, assessment tools, and procedures. Second, the raters of children's illness concepts must not be aware of children's cognitive developmental level in order to prevent observer bias and expectancy effects. Third, confounding variables such as intelligence, socioeconomic status, amount of illness in family, type of illness child may have, and severity of illness must be controlled for. Fourth, assessment of reliability of instruments used to assess concepts must be carried out and reported. Fifth, content, convergent, and discriminant validity of measures of children's concepts of

illness need to be assessed.

Children's Concept of Pain

In order for a child to respond to pain in an adaptive manner, an understanding of what pain is and what causes it is required. There is little, if any, research from the disciplines of sport medicine or sport psychology which addresses athletes' understanding of pain and injury. The psychological literature contains numerous studies concerning this issue, but the subjects have been drawn from general samples and are not specifically athletes. Craig, Grunau and Branson (1988) provide a brief review of research concerning children's understanding of pain and conclude that cognitive changes have great impact on children's conceptualization of pain. Specifically, increases in cognitive development allow for a more sophisticated understanding of pain.

Support for the application of a Piagetian model to children's understanding of pain comes from the work of Anne Gaffney and Elizabeth Dunne (Gaffney, 1988, 1993; Gaffney & Dunne, 1986, 1987). The results of their research were guided by and interpreted within a Piagetian framework. When asked to complete the sentence "Pain is ...," children aged 5 to 7 years most often responded with answers indicating that pain was a "thing" (pre-operational concept), 8- to 10-year-olds described pain as "feeling or sensation", and 11- to 14-year-olds incorporated physiological and/or psychological definitions (formal-operational concepts) such as worry, anxiety, a warning something is wrong, or the nerves' response to injury (Gaffney and Dunne, 1986).

When the same children in the above study were asked to complete the

sentence "A person gets a pain because...", the majority of the responses involved themes of self-causation or transgression. This indicates that many children believed that pain is often a result of something they have done wrong, such as being careless or disobeying rules. Although older subjects gave more objective and abstract answers, only 10 of the 680 subjects provided physiological causes for pain (Gaffney & Dunne, 1987). See Table 2.2 for a summary of the children's responses to the question regarding causes of pain.

Table 2.2. Percentage of children in each age group using particular themes to answer the question "A person gets a pain because..." (Gaffney and Dunne, 1987).

Theme	5-7 years	8-10 years	11-14 years
Trauma	15.9	27.1	44.3
Transgression, eating	26.8	26.6	17.8
Illness, sickness	24.7	15.9	16.2
Transgression, general	7.2	20.0	17.5
Psychological	2.5	4.6	18.5
Transgression, other	5.7	8.7	12.0
Contamination, contagion	4.1	8.7	5.8
Malfunction	1.0	2.6	11.8
Need states	5.1	5.7	2.1
Direct punishment	1.5	2.1	1.7
Physiological	0.0	1.0	2.7
Transgression, health risk	0.0	0.5	2.4

Note: some subjects contributed to more than one category.

The results of the above research indicate that children, especially those in the 5- to 10-year age range, do not have a clear understanding of what pain is and what causes it. Of course, these children were not asked about a specific type of pain, for example, in the leg or head, and, therefore, presumably responded based on their personal experience with pain. Still, the lack of a physiological understanding of pain may lead children to overlook potentially serious injuries and

explain them away as results of an accident or mistake (Gaffney & Dunne, 1987) without understanding the implications for their own future health and sport activity (Thornton, 1990).

There are limitations to the work of Gaffney and Dunne (1986, 1987) cited above. One limitation is that a measure of the children's level of cognitive development or their mental age was not included. The children were assumed to be in a particular stage based on their chronological ages. However, because the responses of the children were coded based on their degree of cognitive maturity, and concepts of pain may not necessarily develop at the same time as other concepts (Bibace & Walsh, 1979; Piaget, 1967), this is not thought to be a serious flaw. However, a comparison of pain concepts to other developmental concepts and mental age would provide predictive and convergent validity.

A second limitation of the research by Gaffney and Dunne is that boys aged 8 years and over, and girls aged 7 years and over, were asked to respond in writing, which may lead to incomplete responses (Ross & Ross, 1988). Gaffney (personal communication, Sept. 1993), however, believes that this method may have led to fewer "don't knows" and provided privacy in which children could respond with things that they may not have discussed in front of another person. This issue will be discussed in more detail below.

A third limitation concerns the nature of the questions themselves and what may be socially learned responses for answering them. For example, it may not be reasonable to expect anyone, including adults, to respond to the question "A person gets pain because..." with an answer based on physiology. When people are asked

what caused their pain or how they injured themselves, the tendency is to describe the event that took place which caused the damage to the body, not the physiological phenomenon itself. This occurs because the person asking the question is usually seeking the former type of information rather than the latter. Gaffney and Dunne did not appear to prompt the children to provide physiological responses, which the children may well have been capable of providing.

Other researchers have found no evidence for clear developmental trends in the understanding of pain. Ross and Ross (1984a) found that their entire sample of 5- to 12-year-old children had a very limited knowledge base concerning definitions and causes of pain. For example, 80.9% of the definitions of pain were unidimensional, with general discomfort or a specific pain event being emphasized. Only 1.8% of the definitions included the process of pain or its function of signalling tissue damage. Of additional interest was the finding that 5.3% of their sample cited secondary gain as a beneficial aspect of pain. For example, the presence of pain could result in not having to give a book report. Finally, Ross and Ross (1984a) found that almost 70% of their sample of children were able to provide excellent descriptors of pain. Some of the pain descriptors included stabbing, burning, squeezing, dull, and pressing. However, Ross and Ross (1984a) did not report whether there were any age differences for the type or amount of pain descriptors elicited by the children.

The methods used by Ross and Ross (1984a) were quite different from those used by Gaffney and Dunne (1986, 1987) in that the former consisted solely of a clinical interview. The impact of this methodology upon results will be discussed

below. Unfortunately, Ross and Ross (1984a) did not describe the responses of the children or the procedures they used to categorize the responses, code the responses, or analyze the data. They merely report an absence of developmental trends based on parametric and non-parametric statistics. Ross and Ross (1984a) also did not include measures of developmental concepts other than understanding of pain and did not assess mental age in their study.

Harbeck and Peterson (1992) differentiated between types of pain in their research. One hundred subjects aged three to 23 were asked questions regarding the value of pain and why pain from an injection, a skinned knee, and a headache hurts. The procedures used by Harbeck and Peterson were also different from those of Gaffney and Dunne (1986, 1987) and Ross and Ross (1984a). In addition to assessing children's understanding of pain, Harbeck and Peterson (1992) assessed the children's prior pain experience and their cognitive developmental level. Prior pain experience was assessed by first asking the child to spontaneously list pains they had previously experienced followed by prompting with a list of frequently occurring pains. Cognitive developmental level was assessed using physical conservation-identity tasks used in a previous study assessing children's concepts of reproduction. Children's understanding of pain was assessed by presenting each child with a set of three vignettes which described either a skinned knee, an injection, or a headache. Children were then asked three questions:

- (1) "How would you describe this pain to your best friend: What does your (type of pain) feel like?"
- (2) "Think about the story...why does your (body part) hurt?"
- (3) "There are a lot of bad things about

pain, what is *good* about this pain?" (p.140).

As did Gaffney and Dunne (1986, 1987), Harbeck and Peterson (1992) then coded the children's responses into seven levels of a continuum of increasing complexity and preciseness rather than imposing pre-determined categories upon the responses. The categories for each scale and some verbatim examples from the children were then sent to children's pain experts who ordered the categories to form the scales used in the analyses. The descriptions of pain given by the children in response to the first question were categorized in the following manner: (a) Unresponsive to the question - medical or psychological treatment (e.g., "should put ice on it", "ignore it"); (b) Unresponsive to the question - cause of injury/pain (e.g., "shouldn't ride so fast"); (c) Unresponsive to the question - reaction (e.g., "I'd cry", "muscles get tight"); (d) General label with no additional specific information (e.g., "bothers me", "hurts", "weird"); (e) Intensity, duration, or location (e.g., "comes and goes", "feels like I could scream"); (f) A metaphor (e.g., "like elephants dancing in my head"); (g) Specific label (e.g., "bumping", "stinging", "bursting"). Responses to the question regarding causes of pain were categorized as follows: (a) Supplies nonsense response or "don't know"; (b) Describes causes of the accident or the headache rather than causes of the pain; (c) Circular response where the vignette is restated with no additional information; (d) Answers an easier question, usually gives a description of the pain; (e) Describes factors contributing to the pain that can be seen or felt, (e.g., "skin came off", "it had dirt in it"); (f) Abstract psychological causes (e.g., "because I think it hurts", "because I didn't expect it", "fear"); (g) Includes internal structures of the body and uses physiological/neurological

descriptions (e.g., "because you scraped off skin and exposed nerves", "increased pressure on the blood vessels").

Results revealed that frequency of previous pain experience was significantly correlated with the ability to define pain ($r = .09$), to understand why pain hurts ($r = .17$), and to understand the value of pain ($r = .10$). However, the authors note that the amount of variance explained by these relationships was very small, and, therefore, had little clinical significance. It is likely that older children have had more experience with pain than younger children, so age may account for the significant correlation between previous pain experience and the understanding of pain concepts. Cognitive developmental level and age were highly correlated ($r = .72$), and the relationship between age and the pain concepts, and the relationship between cognitive development and the pain concepts, did not differ from each other. Based on these results, Harbeck and Peterson (1992) performed further analyses using age as the independent variable, although results using cognitive developmental level as the independent variable would be similar.

Although there were differences between the age groups, the differences were not always linear and were not always between the same age groups. Very young children could not articulate responses to the questions asked of them while older subjects provided responses emphasizing physiological and psychological factors. The majority of the subjects were unsuccessful at providing reasons why pain could be beneficial. Although they were able to perceive the preventative value of an injection, they had difficulty understanding the value in a headache or a skinned knee. In response to the question regarding the value of pain from a skinned knee,

the most frequent response was "don't know." The second most frequent response reflected the concept of secondary gain. For example, subjects were aware that pain could be used to receive attention and sympathy from others and to avoid unpleasant tasks. Overall, 45% of the sixth grade children and 25% of the college students in the study did not identify a value for pain. These results indicate that, when presented with descriptions of physiological pain, children are unlikely to perceive the pain as a signal that they should seek help or stop whatever may be causing the pain. Of course, these results tell us nothing about what children actually do when they experience various types of pain.

In addition to the studies discussed above, there are studies which have not been guided by a Piagetian framework. Nonetheless, they have produced results similar to those using Piagetian theory. In studying 10- and 11-year-olds, Schultz (1971) found that only 11-year-old children viewed pain from a psychological viewpoint while most 10-year-olds described pain in physical terms. Savedra, Gibbons, Tesler, Ward and Wegner (1982) reported that 48% of the 9- to 12-year-old children in their sample responded "nothing" when asked what is good about pain and 16% said "don't know." Although Savedra et al. stated that there were no age differences between children who could or could not think of a benefit of pain, or among the descriptions of pain given by the children, they provide no statistics to support this assertion and the impact of cognitive development was not considered. There is also evidence to suggest that age influences children's responses to questions regarding health, such that older children display more abstract thinking in their discussion of health (Natapoff, 1978). Finally, researchers have found

developmental trends in the strategies children use to cope with pain. Younger children tend to have few coping strategies, relying on direct action techniques such as calling a parent. Older children employ cognitive coping techniques, such as distraction, in addition to direct action techniques (Branson & Craig, 1988; Siegel & Smith, 1989). As children mature, they tend to catastrophize less when faced with stressful and painful events, replacing this strategy with cognitive coping skills (Brown, O'Keeffe, Sanders & Baker, 1986).

Methodological problems. Although the above data suggest that children's understanding of pain depends upon their level of cognitive skill, only Harbeck and Peterson (1992) assessed the children's level of general cognitive development. Children in various age categories were sometimes assumed to be in particular stages of Piagetian development on the basis of possessing average intellectual skills. It is important for researchers to clearly distinguish between chronological age, mental age, and cognitive development in their studies, as these terms have very different meanings and implications. Studies which report correlations among the three descriptors and the concept being assessed would provide the most information concerning concept formation.

Some researchers did not clearly report on the methods used to obtain data or to code, categorize, and analyze the data. In order for consistent methods to be adopted in this field of research, it is important to determine, through replication, which methods are most reliable and valid. This can only be accomplished if researchers publish these details.

Most studies either did not report on the gender of the experimenters who

interviewed the children, or did not balance interviewer gender. It is important to use both male and female experimenters with male and female subjects in order to determine or control for any effects of interviewer gender on the children's responses.

Some studies had the same interviewer who assessed cognitive developmental level subsequently assess pain concepts. This process introduces the possibility of observer bias in that the researcher who knows a child to be within a particular stage of development then expects the child to respond to questions assessing other concepts, such as pain, in a manner consistent with general developmental level.

Distinguishing Between Pain Signals

Melzack and Wall (1988) differentiate three types of pain according to a time frame: transient, acute, and chronic. Transient pain is of brief duration and has little consequence to the person. An example in gymnastics would be an athlete bumping his or her knee on a piece of equipment. The pain may initially be intense, but dissipates quickly. Acute pain is the result of an injury and reflects the combination of tissue damage, pain, and anxiety. Anxiety is the result of perceived consequences of the injury and is greater when prolonged suffering is a possibility. Thus, acute pain includes a review of past injuries and an assessment of the possibility of future recovery. Pain from a sprained ankle is an example of acute pain. Chronic pain is that which occurs following the physical healing of an injury. Since chronic pain serves no useful function, it is often accompanied by feelings of helplessness and hopelessness in those who suffer from it.

As reviewed earlier, the literature suggests that there are at least three types

of pain that may be experienced by athletes: a) pain due to exertion (*training pain*); b) pain that signals impending injury (*warning pain*); c) pain that is indicative of injury (*injury pain*). Warning pain is thought to be the most difficult to respond to appropriately as it requires the ability to determine the quantity of pain that can be endured before an injury occurs, and/or to determine what qualities of pain indicate impending injury. The ability to distinguish these types of pain is extremely important for athletes, as heeding the signals of pain is crucial for continued success in sport. Being able to distinguish between these types of pain and respond appropriately to them is important for athletes' longevity in sport. It is this ability which is being assessed in this study, so a review of human capability in this area would be informative. Unfortunately, there does not appear to be much in the way of literature concerning this ability. The reports of athletes' skill in this area are mostly anecdotal in nature, and all concern adult athletes.

Cognitive Development and Implications for Athletic Injury

Child athletes presumably develop an awareness of their bodies' functioning through observation, instruction, cognitive maturation and direct experience. Thornton (1990) has observed that this awareness is highly developed in professional adult athletes, therefore, it may develop at a more rapid pace in athletes than in the general samples studied by Gaffney and Dunne (1986, 1987) and Harbeck and Peterson (1992). However, the process of development of an advanced understanding of pain and injury prevention has not been studied.

The evidence presented above suggests that an immature concept of pain and injury, combined with social pressure, may cause a child to continue to engage in

sport after sustaining a potentially serious injury. Although the idea that a child has difficulty differentiating types of pain and responding appropriately to different types of pain is intuitively appealing, there exists no empirical evidence to support this idea. For a number of reasons, it is important to know if children can distinguish between pain indicative of a potential or actual injury versus pain indicative of achieving a training effect. First, children may inaccurately report their pain (Gaffney, 1988, 1993), or may over-report it as a way to seek attention or secondary gain (Harbeck and Peterson, 1992; Snyder, 1990). Children who over-report their pain run the risk of not being taken seriously if they eventually suffer a real injury. Children may, therefore, benefit from education concerning the different types of pain and what pain may signal and the relationship between injury-related pain and the long-term consequences of suffering injuries.

Second, it is clear from the literature reviewed here that many children are engaged in extensive athletic training which may elicit pain before they are well equipped to understand the signals that pain sends to them. In a sporting context, this normal feature of development has important implications for training procedures and for action taken when an athlete presents with pain. For example, coaches may need to receive information regarding the dangers of repetitious practice techniques for young athletes and need to be aware that children have difficulty in accurately describing and understanding their own pain.

Third, it is also important to know how young athletes respond to various types of pain in order to correct practices which may have negative long-term effects on athletes' physical health or may prevent optimal development in a particular

sport. For example, athletes who quit their sport due to concern over training pain may not develop in that sport to their fullest potential, while those who continue to play with warning or injury pain may run the risk of serious long-term injuries.

Fourth, children often do not have the same level of access to qualified athletic trainers and other health care professionals as do adults (American Academy of Pediatrics, 1983; Lord and Kozar, 1989; Micheli, 1984). The absence of qualified health personnel places an extra burden on parents and coaches who often must help children make decisions regarding whether or not to play through pain. Adults need to be aware that the children they are responsible for may not have the cognitive skills required to make such a decision for themselves. Fifth, when they do go to health care providers, athletes' self-reports are often used to diagnose injuries and young children may not be able to provide an accurate report of their pain to the health professional. It is important, therefore, to determine at what age athletes are able to accurately describe their pain and differentiate types of pain.

Finally, it is important to determine what children of various ages understand regarding pain and injury in order to develop effective intervention programs for injury reduction. Although it is not known at what age, if ever, an athlete develops the ability to make sound decisions regarding playing through pain, it is possible to improve children's knowledge of pain through specific instruction. Ross and Ross (1985) taught 9- to 10-year-old children about the function of pain as a warning, its value in diagnosis and treatment, and how it can be used maladaptively. Following a 20-lesson pain program, children scored significantly better on a post-test assessing knowledge of the content of the pain program than they did on a pre-test. Although

the children were able to learn the content of the program, it is not known whether they applied what they had learned in the classroom to their daily lives. The impact and value of such a program is, therefore, unknown.

There is evidence to suggest that injuries in a sporting context can be reduced by addressing a number of factors. Ekstrand, Gillquist and Liljedahl (1983) implemented and evaluated the effectiveness of a program designed to reduce soccer injuries in athletes aged 17 to 34 years. The program focused on the following areas: (a) appropriate training techniques; (b) optimum equipment; (c) prophylactic taping of vulnerable body parts; (d) controlled rehabilitation; (e) exclusion of players at risk due to physical conditions; (f) education regarding the importance of disciplined play and the increased risk of injury during practice; (g) attention from doctors and physiotherapists. Over a 6-month period, the athletes who participated in the program sustained 75% fewer injuries than the control subjects. It is possible that a similar type of program aimed at the needs of younger athletes may produce a similar reduction in sport-related injuries. In addition to the above components, younger athletes may require education concerning the value of pain and the importance of heeding the warning function of pain.

The next section of the literature review addresses issues in the measurement of pain. The first parts deal with the impact of theoretical models of pain and injury on the assessment of pain. It is necessary to examine the models of pain in order to understand how they influence the questions asked of research participants and the interpretation of research results. Following this review, literature concerning the assessment of pain in children is presented. This literature reveals that there are a

number of important methodological issues to address when assessing children's pain experience. Finally, the little research available on measuring athletes' response to sport-related pain is presented.

Models and Measurement of Pain

Models of Injury

Injury is typically described as something that occurs once and results in acute impairment. Waller (1987) has proposed that injury be described as a disease. This etiologic description allows injury to be described in the same way as chronic disease, that is, as an impairment resulting from prolonged exposure to some injurious substance or condition. For example, although the kinetic energy from a jackhammer can put a hole through someone's foot in an instant, it can also result in deafness or white finger syndrome after many years. In the context of sport, a body check in hockey may result in a concussion, but receiving many body checks over many years may result in chronic joint problems.

Waller's analysis of injury allows injury to be viewed as a social problem resulting from correctable environmental hazards. Although this approach does not mean that the individual has no responsibility in preventing injuries, it does mean that environmental responsibility is emphasized. The emphasis is on the environment because Waller sees voluntary behavior on the part of individuals as interacting with other factors which initiate the injury event or determine its course.

Models of Pain

Research in the field of pain has been dictated by various models. Abandonment of the specificity and pattern pain models in favour of the gate-control

theory of pain (Melzack & Wall, 1965) allows researchers to take account of both physiological and psychological components of the pain experience. However, the gate-control theory is a biologically based theory and does not adequately address the psychosocial aspects of pain (P. J. McGrath et al., 1991). Fordyce's (1976) operant model of pain emphasizes the importance of the pain patient's behavior and reinforcement for that behavior. Significant others in the pain patient's environment, according to Fordyce, may reinforce some maladaptive pain behaviors. These behaviors can only be eliminated by manipulating the reinforcement contingencies. The environmental factors stressed in Fordyce's model are exclusively human, in contrast to the emphasis Waller (1987) puts on safety equipment and laws in his model of injury.

The cognitive-behavioral model (Turk & Meichenbaum, 1989) stresses the importance of an individual's thoughts in influencing the experience of pain. That is, how people perceive their pain influences their experience of it. Turk and Meichenbaum's model is especially relevant to this dissertation as the emphasis here is on gymnasts' perception of their pain and how that perception differentially influences response to pain. Although both the operant and cognitive-behavioral models of pain contribute a great deal to understanding the experience of pain and treatment of it, neither of them account for the broader environmental and social factors which impinge upon the pain experience (P. J. McGrath et al., 1991).

In order to account for both environmental and social factors, P. J. McGrath et al. (1991) have proposed that pain be described within the World Health Organization (WHO) International Classification of Impairments, Disabilities and

Handicaps (World Health Organization, 1980). According to this classification system, disease occurs in four planes of experience. On the first plane, disease occurs as an abnormality. When someone becomes aware of the abnormality, the second plane is realized. This second plane is referred to as an impairment. The third plane occurs when the person is disabled from doing normal, everyday activities. The fourth plane of experience is handicap, which occurs when the impairment or disability results in social disadvantage for the individual. In the context of professional tennis, repetitive strain injury would be the disease, pain would be the impairment, and inability to perform an effective tennis stroke would be the disability. Inability to compete could be considered a handicap if it results in the individual suffering financial difficulties or loss of social role.

The WHO model of consequences of disease is particularly useful for studying sport-related pain because it helps to identify the various factors which contribute to pain in sport. As with injury (Waller, 1987), there are many environmental influences which contribute to pain and determine its severity. P. J. McGrath et al. (1991) have identified environmental factors in the home, hospital and school, and human factors in the child, parent and other adults and peers that may contribute to the experience of pain in children. For example, environmental factors may include aversive sights, smells, and activities associated with the pain event. These factors may become cues for pain and may serve to intensify the pain experience. Human factors may include anxiety levels and personality factors in both the patient and significant others. This analysis of pain fits with the literature discussed previously which identified parents, peers, and coaches as having great

impact upon how young athletes react to their pain and injuries.

Measuring Children's Experience of Pain

Erroneous beliefs regarding children's relative insensitivity to pain have been responsible for the delay in the development of reliable and valid measurement instruments for pediatric pain experience (Craig et al., 1988; Eland & Anderson, 1977; P. J. McGrath & Unruh, 1987; Ross & Ross, 1984a; Thompson & Varni, 1986). Although the accuracy of measurement of pain in children has improved a great deal during the past 10 years, assessment of pain is not as advanced as measurement of pain (P. J. McGrath et al., 1991). Assessment refers to the whole experience of the pain event, including all elements that impact upon the experience, while measurement is concerned only with some specific aspect of pain, such as intensity or duration. Due to the subjective nature of pain, it must be assessed using indirect measures such as observation or self-report. Self-report may be problematic for use with children due to their limited cognitive capacity to understand their pain experience and linguistic ability to describe it. However, children have been shown to be able to give accurate and reliable reports of their pain experience using self-report measures such as pain adjective descriptors, visual analogue scales, category or graphic rating scales, numerical rating scales, pain drawings, and direct questioning (Abu-Saad, 1981; Jerrett, 1985; Lavigne, Schulein & Hahn, 1986; LeBaron & Zeltzer, 1984; P. A. McGrath, 1990; P. J. McGrath et al., 1991; P. J. McGrath & Unruh, 1987; Ross & Ross, 1988b; Varni, Thompson & Hanson, 1987; Wilkie, Holzemer, Tesler, Ward, Paul & Savedra, 1990). The methods relevant to this dissertation are visual analogue scales and direct questioning.

Visual analogue scales (VAS) consist of a vertical or horizontal line anchored at one end with a descriptive word or facial expression indicating no pain and at the other end with a picture or word to indicate worst pain possible. The VAS contains no words other than those at the endpoints, so it is particularly useful for very young children who may not fully understand the meaning of words such as "moderate" or understand the number concepts used on numerical rating scales (Ross & Ross, 1988a). When clear, simple instructions and practice sessions are used, the VAS has been shown to be a valid and reliable tool to measure the experience of pain in children aged 5 years and over (Abu-Saad & Holzemer, 1982; P. A. McGrath, de Veber & Hearn, 1985; Varni, Thompson & Hanson, 1987).

Direct questioning methods allow not only for a measurement of immediate reactions to pain, but also reveal information regarding coping methods used by the individuals and beliefs and opinions regarding their pain experience (P. J. McGrath et al., 1991). That is, direct questioning provides an assessment of the entire pain experience, rather than a measurement of some dimension of pain. Direct questioning does have its shortcomings as a method of assessing pain in children. Some of these shortcomings are a result of children's limited experience with pain, their limited cognitive understanding of what researchers are asking them, and their limited verbal ability to express themselves (P. J. McGrath & Unruh, 1987). Although these abilities constantly improve as children grow older and acquire more advanced cognitive skills, they cannot be ignored when assessing pain experience. Another problem inherent with self-report measures of pain concerns the demand characteristics of the situation in which research questions are asked (P. J. McGrath

& Unruh, 1987; Ross & Ross, 1988a). For example, children may deny they have pain if they think that admitting their pain will result in receiving a needle (Eland & Anderson, 1977).

The shortcomings mentioned above can be addressed by attending to some important aspects of interviewing (Ross & Ross, 1984b). These aspects will be considered further in the methods section. Briefly, they are: (a) the type of information sought (factual versus beliefs, opinions, ideas, reasons, or descriptions); (b) participant comprehension of questions; (c) number of questions asked; (d) psychological climate; (e) subject set.

Purpose and Rationale

Given the results of research reviewed above, responsible adults would have some reservation about children participating in activities where the potential exposure to pain and injuries exists. The above research indicates that young children do not appreciate the value of pain as a signal to stop activity and attend to the pain, are unable to provide good pain descriptors to health care professionals, and, according to Gaffney and Dunne (1987) often tend to believe that pain is due to their own misbehavior. However, these results may not be valid for all types of children, especially for children participating in sport where the potential for pain and injury exists on a daily basis. Athletic children may have a greater understanding of pain and injury.

The present study was designed to elucidate the development of a number of concepts relevant to young gymnasts' understanding of sport-related pain. This study was expected to shed light on what athletes of different ages and developmental levels understand about the functions of pain, whether they respond differentially to different types of pain, and what things motivate them in their decisions regarding what to do about pain. Of interest was participants' ability to differentiate types of sport-related pain and the reasoning they use in responding to those types.

Three types of pain were discussed in the literature review: training pain, injury pain, and a type of pain in between these two which is being referred to as

"warning pain." Being able to distinguish these types of pain is extremely important for athletes, as they must know whether or not it is safe to continue their sport despite having pain. In addition to the three types of pain discussed above, it was expected that the gymnasts in this study may identify other types of sport-related pain, such as muscle soreness the day following a work-out.

In addition to determining the types of pain the gymnasts were experienced with, questions were posed to the participants designed to elicit other beliefs they have regarding pain. For example, they were asked what they believe the cause of pain to be, and prompted to identify physiological and psychological causes. They were also asked to provide descriptors for their pain, to define an injury, and to generate reasons why pain is a good thing. Answers to these questions provide information regarding developmental differences in gymnasts' beliefs about, and uses of, sport-related pain. Although there was no comparison group in this study, it proved informative to compare the results of the above questions to similar questions posed by researchers studying general (i.e., not specifically athletic) populations of children.

The present study was also designed to determine whether understanding of the various pain concepts could be predicted by information readily available to coaches and/or parents. For instance, it was thought that factors such as training hours per week and experience with pain and injury may significantly influence performance on the research questions. Knowing what factors may lead to an enhanced understanding of pain and its consequences may assist adults who are trying to help young athletes make decisions about participating in sport despite

pain.

This research project was, in part, given impetus by the potential impact the results may have on sport policy. For example, if it were determined that young athletes are unable to differentiate types of pain and tend to respond inappropriately to pain, it may be important to implement standards requiring young athletes reporting pain of any type to have access to consultation from a health professional. The results were also expected to have implications for coaches and parents who often must make decisions as to whether a child should continue to participate in sport while experiencing pain. Adults need to be aware that children may have difficulty accurately describing the experience of pain, and, as a result, may not be able to inform their coach or parent of a potentially serious injury. Such information could be incorporated in coaching clinics, so that coaches may respond to children's pain in the safest manner.

The proposed research was also expected to contribute to completion of the Haddon matrix, as recommended in the report on *Injuries in Saskatchewan*, in the cells concerning human factors at the pre-event, or primary prevention, phase. Completion of these cells may indicate target areas for programs focusing on injury prevention. At a social policy level, the results of this and similar studies may lead to reforms in sport that would serve to decrease health care costs due to the treatment of sport-related injuries. One example would be programs designed to teach young athletes the various functions of pain and how to respond appropriately to pain. Thus, it was hoped that this research project may help to meet one goal of the World Health Organization, which is to reduce the severity and extent of injuries

due to sport.

Finally, if children are to be taught safety procedures and pain management for the purpose of injury prevention, their cognitive capabilities in this domain must be determined before initiating instruction. If what athletes understand about pain and injury prevention can be established, it may then be possible to implement effective prophylactic programs. To the extent that children are unable to understand what they are being taught, they will not benefit from instruction. It was expected that this study would provide useful information regarding young gymnasts' knowledge of pain and injury for those undertaking the task of teaching such athletes injury prevention.

Hypotheses

Hypothesis 1) *Relationship between chronological age, mental age and cognitive developmental level.* It was hypothesized that cognitive developmental level, mental age, and chronological age would (a) be positively correlated with each other, and (b) would not differentially predict performance on any of the interview questions regarding pain concepts. For the remaining hypotheses described below, the term "age" is used to connote the three variables of chronological age, mental age, and cognitive developmental level.

Hypothesis 2) *Sex differences.* Research with children has revealed no sex differences on the variable of response to pain (cf. Bournaki, 1997). In general, the results of pain research concerning sex differences has been conflicted (cf. Lautenbacher & Rollman, 1993). Sex differences were not expected to occur in this study and were examined post hoc on a number of variables in order to justify

collapsing participants across sex.

Hypothesis 3) *Number of different types of pain identified.* Age was expected to predict ability to identify different types of pain.

Hypothesis 4) *The distinction between exertion and pain.* It was expected that the older participants would be less likely to describe sensations due to exertion as "pain."

Hypothesis 5) *Rationales per response to pain.* Older gymnasts were expected to consider more factors than were younger gymnasts in explaining their particular responses to pain.

Hypothesis 6) *Use of pain descriptors.* Age was expected to predict level of sophistication used in describing how pain felt.

Hypothesis 7) *Injury definition.* Age was expected to predict more comprehensive definitions of an injury.

Hypothesis 8) *Understanding of pain causality.* Age was expected to predict a more cognitively mature understanding of pain causality.

Hypothesis 9) *Understanding the value of pain.* Age was expected to predict ability to identify more valuable aspects of pain.

Hypothesis 10) *Secondary gain.* Participants were expected to report using pain for secondary gain both in the context of gymnastics and at home or school. Further, they were expected to report using pain to account for poor gymnastics performance.

Hypothesis 11) *Prediction of understanding of pain causality.* It was predicted that the variables of number of training hours per week, injury experience,

and number of different pain types identified would predict pain causality scores when these variable were entered in a multiple regression analysis.

Hypothesis 12) *Cognitive techniques*. Age was expected to predict more frequent use of cognitive coping strategies in response to pain.

Hypothesis 13) *Degree of danger posed by gymnastics*. There have been instances where the media has portrayed gymnastics as a dangerous sport due to the amount of pain and number of injuries suffered by young children. Participants were expected to report gymnastics as the event which caused the most pain they had ever experienced.

Method

Participants

Gymnasts were recruited from four gymnastics clubs: three clubs in Saskatoon SK and one in London ON. All available gymnasts were recruited in Saskatoon and additional participants were recruited in London in an attempt to have equal numbers of participants at each age. There were only four gymnasts recruited from London, so use of gymnasts from a different geographical location was not thought to significantly effect results.

Gymnastics was chosen for a number of reasons. First, the sport attracts athletes from a wide age range. Second, both males and females compete in gymnastics. Third, this sport requires a relatively high number of training hours per week, which means that athletes were more likely to have exposure to a variety of types of pain, for example, due to overuse of body parts, acute injuries, chronic injuries, and exertion. Fourth, gymnastics has a relatively high rate of injury (Ellison & Mackenzie, 1993), which meant that injury-related pain was unlikely to be a foreign topic for the participants.

Use of a second or multiple sports was considered. However, pilot studies (discussed below) revealed that gymnasts had much greater experience with pain and injury than other athletes. It appeared that results would be more robust using gymnasts as there would be more variability across the age span in terms of injuries. Since experience with injuries was expected to contribute to athletes' understanding

of pain, a decision was made to use a population which had more experience with injuries and pain. Using combinations of different sports had the potential to produce invalid results as there may have been no difference in injury experience across the age span.

Elite athletes have been shown to tolerate more pain than more recreational athletes (Scott & Gijssbers, 1981), and this difference may be due to the fact that competitive athletes are more motivated to endure pain. It was important, therefore, that all athletes in the present study be competitive rather than recreational. This requirement helped ensure that athletes were more likely to have had experience practicing and competing with pain than athletes practicing their sport recreationally. In addition to being competitive, athletes had to be practicing a standard number of hours per week. To select athletes not training a standard amount of time would have resulted in an invalid sample. For example, a 12-year-old training 24 hours per week is involved in gymnastics for reasons different from those of a same-aged child training only 4 hours per week. Experience with pain and desire to train with pain would probably be vastly different for these two children. Coaches were asked to give consent forms only to children who were training competitively, that is, not to include children who were recreational as opposed to competitive athletes. (Table 5.2 in the Results section shows number of training hours by sex by age).

Gymnasts between the ages of 6 and 13 years were recruited. A total of 68 athletes participated, as shown in Table 4.1. Since there were more females than males in the youngest age groups, the possibility for a confound of gender across ages existed. However, the results of analyses aimed at determining sex differences

across various measures suggest that such a confound did not exist.

Table 4.1. Participants by age and sex.

	Age								Total
	6	7	8	9	10	11	12	13	
Male	0	0	5	1	5	5	5	4	25
Female	5	5	6	6	5	5	5	6	43
Total	5	5	11	7	10	10	10	10	68

Measures

Mental age. Two subtests from the Stanford-Binet Intelligence Scale - Fourth Edition (SB-IV: Thorndike, Hagan & Sattler, 1986) were used to assess participants' level of performance on standardized measures of IQ. The Vocabulary and Pattern Analysis subtests were used to assess performance in the Verbal Reasoning and Abstract/Visual Reasoning content areas. These two subtests have high test-retest reliabilities, $r = .87$ and $.92$, respectively, and have been used together as a short form IQ test (Sattler, 1988). Each test also correlates well with the composite IQ score, $r = .81$ and $.74$, respectively. Since the use of age-normed scores (such as SB-IV standard age scores) would result in the loss of a developmental perspective, raw scores were used in order to differentiate participant performance by age. For example, a 6-year-old and a 10-year-old each of average intelligence may have very different raw scores, but the act of transforming them into standard scores would obscure this difference. Therefore, raw scores were standardized (z-scores) by subtracting the mean of the full sample (i.e., across all ages) from the raw score and dividing by the standard deviation of the full sample. The two resulting scores

were summed and then the sums were transformed into z-scores to produce a single score for each child; this variable was referred to as the SB (Stanford-Binet) score having a mean of 0 and a standard deviation of 1.00.

Cognitive developmental level. The Concept Assessment Kit (KIT: Goldschmid & Bentler, 1968) was used to determine the Piagetian cognitive developmental level of participants aged 6 years to 7 years, 6 months. The KIT is a standardized test assessing the concept of conservation using two-dimensional space, number, substance, continuous quantity, weight, and discontinuous quantity. KIT scores are reported to be highly reliable ($r = .94$) and the items have high internal consistency ($r = .96$). Scores on the KIT have been shown to correlate with academic achievement ($r = .45$), IQ ($r = .31$), and measures of other cognitive concepts such as probability ($r = .23$) and perspective ($r = .25$), demonstrating the validity of the device. Since the items on the KIT are quite redundant and have high internal consistency, only half of the KIT items were used in this study. The items used were: B - Conservation of Number; C - Conservation of Substance; and D - Conservation of Continuous Quantity.

The cognitive developmental level of participants older than 7 years, 6 months was assessed with three tasks based on those originally used by Inhelder and Piaget (1958). Two derivatives of Piaget's original tasks have been used by more contemporary researchers (Linton, 1994; Martorano, 1977) to assess formal operational thought. The first task used by these researchers consisted of asking participants to find all possible pairs that can be constructed with five different colored cubes. The second task consisted of giving participants four different

colored cubes and asking them to make all possible combinations of the cubes. Performance on these types of tasks has been found to correlate positively with grade in school (Martorano, 1977) and with scores on a mini mental state exam, which is another measure of cognitive functioning, in patients with varying degrees of dementia (Linton, 1994). Preliminary data have demonstrated performance on the second task to remain consistent over a three-year period for adult patients who have not experienced a decline in abilities due to dementia (Linton, 1994).

In scoring the tasks, Linton (1994) viewed the passing of one of the tasks as an indication of formal operational thought. Martorano (1977) classified participants as either early or late formal operations based on the behavior characteristic of the participant during the task. The early formal operational stage was characterized by systematic attempts to find a solution without a real plan, whereas late formal operations was characterized by setting aside one variable in order to examine others. The ability to isolate variables in the late formal operational stage allows the participant to find new variables (Inhelder & Piaget, 1958).

For the present study, it was important to differentiate participant performance on the Piagetian tasks as finely as possible in order to use cognitive developmental level as an independent variable. It was decided, therefore, to look at the number of omissions and repetitions produced by each participant on each task. Such a score gave a very clear indication of the use of a systematic method of isolating variables. That is, the more a participant was able to systematically isolate variables, the fewer omissions or repetitions were made. During pilot testing, it was discovered that even 8-year-olds had no trouble with the "pairs" task, so the tasks

were modified to create a more difficult test of the ability to isolate variables. There were three separate tasks: a) making all possible pairs out of 4 blocks; b) making all possible triads out of 4 blocks; c) making all possible triads out of 5 blocks. Each participant aged 7 to 13 received scores indicating the number of omissions and number of repetitions on the Blocks tasks.

Understanding of sport-related pain. Over two phases, an interview to assess a number of different sport-related pain concepts was developed. See Appendix A for a summary of pilot participants. In Phase 1, a sample of athletic children from various sports was recruited to design an interview to assess participants' (a) ability to distinguish types of sport-related pain, (b) responses to types of sport-related pain, (c) reasons for their responses, (d) understanding of what would happen to their bodies if they continued gymnastics with different types of pain, (e) ability to describe pain they had felt, (f) ability to define an injury, (g) understanding of pain causality, (h) understanding of the value of pain, and (i) use of pain for secondary gain. Based on the responses to the initial interview, items most useful for the age span under consideration were retained and these items formed the Response to Athletic Pain Interview (RAPI - Appendix B).

As described in the literature review, there are some problems with using interviews in research with children. In an attempt to avoid such shortcomings in the development of the RAPI the recommendations of Ross and Ross (1984b) were followed. Ross and Ross (1984b) discuss five important aspects of conducting interviews with children. First, the type of question asked may determine the type of response given. There are two types of responses to questions that researchers

generally seek: (a) factual information, and (b) beliefs, opinions, ideas, reasons, and descriptions. When factual information is sought, the supplied answer format of questioning is useful. For example, information to a question such as "Have you ever had pain?" is designed to elicit simple yes or no responses. However, in order to determine beliefs regarding the different functions of pain or the cause of pain, a generate format allows for more accurate and detailed responses. Rather than asking "Did falling cause your pain?," the appropriate question would be "What caused your pain?" The former format may bias a participant's response while the latter format allows the respondent to answer in any number of ways without being constrained to a yes or no response.

The generate format has also been demonstrated to elicit more accurate response content compared to the supplied format in terms of words children use to describe their pain. When pain descriptors are supplied to the children, they often choose words for reasons beyond the term being a good descriptor of their pain (Ross & Ross, 1984b). For example, children may think that choosing certain words will help them to avoid getting a shot of pain medication. Although the generate format is more time-consuming to administer and score, it yields more valid response content (Ross & Ross, 1984b; Wilkie et al., 1990). RAPI items were in the generate format.

A second important aspect of interviewing is question comprehension. When using any format of questioning, the researcher must be aware that young children have a tendency to answer questions even if they do not really understand what is being asked of them. For example, 15 out of 16 children aged 5 and 7 years

supplied answers and reasoning to bizarre questions such as: "Is red heavier than yellow?" and "Is milk bigger than water?" (Hughes & Grieve, 1980). If question comprehension is not ensured the data may reflect something other than children's true understanding of the concepts being assessed. During piloting questions children did not understand were constantly modified to ensure comprehension.

The third way to ensure valid and reliable results from interviewing children is to pay attention to the number of questions asked within a given time frame. When a comprehensive cluster of questions is used for one specific topic, children may be overwhelmed with the number of questions and may not be able to relax enough to provide all of the information they may have. Alternatively, the use of temporally spaced questions, presented within the context of a conversation, allows children to recall information that did not occur to them during the initial questioning of the topic. During administration of the RAPI the interviewer made every effort to engage the child in conversation and switched topics if a participant appeared confused or bored.

A fourth component of successful interviewing pertains to the psychological climate. Researchers should make every effort to ensure that children understand participation is voluntary and feel relaxed throughout the interview. The whole interview should resemble a conversation and should be unhurried. Children should never be expected to write their answers as their verbal ability exceeds their written ability (Ross & Ross, 1984b). Administration of the RAPI was audiotaped and no notes were taken during the interview.

A fifth important component of the interview concerns the subject set. It is

important for children to feel that what they have to say is important and that they feel confident they are meeting the requirements of the interview. It is important to instill this set at the beginning of the interview and this can usually be accomplished by using a "warm-up question cluster" which the child finds interesting (Ross & Ross, 1984b). Such a cluster includes questions that the child can answer easily, such as, "How old were you when you started gymnastics?", "How often do you train?", "How do you get to the gym?". It is important to maintain this subject set by not allowing children to become discouraged by difficult items. This can be accomplished by prefacing difficult items with easier ones. For example, before asking gymnasts to justify their responses to pain they were first asked to justify why they liked gymnastics. The interviewer then used probes in order to get the most complete answer possible from the child. The use of probes on the easier questions increases the probability that the child will give more complete answers on the key research questions (Ross & Ross, 1984b).

In Phase 2 of the study, the RAPI was administered to another small sample of athletes. This second phase had four purposes: (a) to develop standardized prompts for the RAPI questions, (b) to develop a scheme for coding participants' responses to the RAPI questions, (c) to train a research assistant to reliably score the responses to the RAPI from audiotape recordings, and (d) to provide the primary researcher with practice using all of the various measures.

During piloting it became evident that some participants could not recall any pain incidents unless prompted and others thought of pain incidents after the initial interview was over and the tape recorder turned off. Piloting also revealed that

many children did not always think to include certain responses in their answer to what they did about pain. Thus, a number of standard prompts were used once participants stated they could think of no other instances of pain, and other prompts were used to elicit common responses to pain. All prompts are included in Appendix C.

Since the primary research administered the RAPI to all participants in the final sample, there was some concern over researcher bias influencing the results of this study. However, Ginsburg (1997) convincingly argues that the interviewer must know the goals of the interview questions in order to effectively prompt children to provide complete answers. For example, in asking children why clouds move, an interviewer should not take "because they want to" as a final response from a child. Prompts must be administered in order to test the extent of the child's knowledge. For example, asking "what's another reason clouds move?" may elicit "because the wind blows them away." Standardized probes such as "tell me more," "what do you mean?" and "what happens next?" were used throughout administration of the RAPI to encourage children to give as much information as possible without biasing their responses.

Each question on the RAPI yielded different and independent responses which were coded independently. Below, each RAPI question and the method used to develop a scoring taxonomy is described.

Question 1 asked participants (a) to describe a type of sport-related pain and (b) what they did in response to that pain. Following this question they were asked a number of other questions about that pain type, and then were asked to describe

another type of pain that felt different or where they responded differently to the pain. In this manner, participants were asked to describe every different type of sport-related pain they had experienced. They received a score reflecting the number of different types of sport-related pain they were able to identify. This score was created by simply counting the number of different types of sport-related pain the athlete described. The taxonomy for coding pain types was derived by the method of analytic induction (Baxter, 1991). Analytic induction is a procedure whereby the researcher logically generates categories that describe the data. Once categories are developed, the researcher tests the hypothesized categories by gathering more data and ensuring that the coding categories are sufficient to contain the data. Originally, three types of pain were considered: (a) pain due to exertion; (b) pain due to injury; and (c) pain warning of possible injury. During piloting, it was evident that athletes experienced other pain types and responded differently to each type. The primary researcher modified the taxonomy by adding coding categories such that all responses could be coded (Baxter, 1991). The taxonomy of pain types can be seen in Appendix C.

Category development for the RAPI questions. Questions 1b, 2, 3, 7 and 8 (see Appendix B) had not previously been used in research. As such, no coding system existed for responses to these questions and the responses were too complex to use the method of analytic induction described above. Instead, the responses of all the participants from phase 2 to the above RAPI questions were written on cards and given to 5 members of a research team (one honours student, one masters student, two doctoral students and one professor) along with the questions posed. A

taxonomic analysis (Baxter, 1991) was conducted whereby the pool of responses to each question was reduced to a taxonomy of categories. Working independently, each team member developed a taxonomy for each RAPI question to which all responses could be assigned. The primary researcher then examined these taxonomies and developed a scoring key for each RAPI question such that the gymnasts' responses could be coded according to pre-determined taxonomies. The taxonomies for each RAPI question can be seen in Appendix C.

Question 1b asked participants what they did in response to pain. Responses were categorized according to the action taken by the child. For example, ignoring the pain was one category while telling someone (coach, parent, trainer) was another. RAPI question 2 asked participants to provide a rationale for their response to pain. Question 2 was intended to determine what factors were considered when responding to the various pain types. RAPI question 3 asked participants what would happen to their bodies if they continued gymnastics with each type of pain they described. Question 3 was designed to determine whether the athletes appreciated the potential consequences of continuing sport with different types of pain. RAPI Question 7 asked athletes to describe how pain can be a good thing. Question 7 allowed for an analysis of participants' understanding of the value of pain. Finally, question 8 asked participants if they had ever said they had pain in order to avoid some undesirable task. This question was intended to determine the use of pain for secondary gain.

RAPI question 4 asked athletes to describe how their different types of pain felt. The words and phrases used by athletes were categorized in order to reflect

developmental differences. The categories were based on previous research (Harbeck & Peterson, 1992). The categories, from most to least cognitively mature, were: (a) a specific label (sharp, dull, tingling, tight, stiff); (b) a metaphor (Like a wrench around my arm); (c) based on intensity (Hurt really, really bad; More than the last one); (d) a synonym for pain (sore, tired, hurt); (e) don't know.

During Phase 2 a scoring system reflecting levels of cognitive development was developed for two questions on the RAPI. The two questions were #5) "Tell me in your own words what an injury is." and #6) "Suppose a gymnast twisted her/his ankle and it hurt. Why does she/he feel pain?" Participants were prompted for physiological content in their answers. Previous studies (Gaffney & Dunne, 1986; Harbeck & Peterson, 1992) using similar methodology have found about six categories ranging from inability to answer the question to use of formal reasoning and hypothetical thought. The taxonomies for coding responses to RAPI questions 5 and 6 were derived by the method of analytic induction (Baxter, 1991) as described above. See Appendix C, questions 5 and 6, for the categories used for each question.

During Phase 2, a research assistant was trained to code responses to the RAPI by listening to tapes of interviews along with the primary researcher. Once the two researchers had reached a high level of agreement between their scoring results, the research assistant coded the interviews independently. The research assistant was blind to the age, cognitive developmental level, and SB score of the participants. Inter-rater reliability of the coding scheme was assessed by having the primary research code a subset of the interviews (22%) and comparing the scores of

the two raters.

It is possible that performance on the RAPI may have depended on memory or reflected a tendency to confabulate information rather than an accurate recollection of what the child did. One way to estimate the tendency to distort or forget information as a function of age is to compare the child's responses to responses of the parent to questions requiring the ability to remember information relevant to injuries. Using this type of methodology, Peterson (1996) interviewed children and parents 2-5 days and 6 months following the child's treatment at an emergency ward for a traumatic injury. Peterson found 4-year-olds to be 95% accurate during both the first and second interview. For the present study, a number of questions were answered by both participants and their parents. Their responses were correlated in order to identify any tendency to forget or confabulate on the part of the participants. This method is described more fully in the results section.

Experience with pain, injury, and sport. In order to obtain background information on participants' experience with pain and injury, the Athletic Pain Questionnaire (APQ - Appendix D) was administered. As opposed to most of the RAPI questions described above, questions on the APQ were designed to seek factual information. It was important to determine information such as number of hours spent training and experience with injury for each participant in order to determine the relationship between such variables and understanding of the various pain concepts.

The APQ questions were developed for this study and consisted of a series of

visual analogue scales and questions. Some questions were designed to elicit data which were used as independent variables in analyses described below (e.g., frequency and intensity of pain, most pain ever felt) and/or as a means to determine participants' tendency to forget or confabulate information. Ratings of pain severity and experience with pain and injury were correlated with the number of different pain types experienced and responses to RAPI questions 5, 6, 7 in order to determine whether participants' responses to these RAPI questions were associated with their experience of pain in the course of participating in gymnastics.

The validity of six-year-old participants' ability to use the visual analog scales (VAS) was assessed with the following procedure. The children first used the VAS to rate the amount of pain they would expect to feel from (a) falling in the snow, (b) a mosquito bite, and (c) falling on a sidewalk (Fowler-Kerry & Lander, 1987). The criterion for continuing with the APQ VAS scales was giving falling on the sidewalk the highest pain rating. The one six-year-old unable to use the scale appropriately has missing data for those particular questions requiring use of a VAS.

Since many of the APQ questions relied on accurate recall of several pieces of information, these questions were also posed to a parent who verified the answer. When interviewed together, the parent and child would discuss the APQ questions and arrive at an answer together. In cases where the parent was interviewed over the telephone at a later date, the mean of the parent's and child's response was used in subsequent analyses.

Procedure

Consent forms, along with a brief description of the study, were given to

coaches who handed them out to gymnasts they identified as training competitively. In addition, the primary researcher provided the gymnasts with a description of the study and what the athletes would be asked to do should they decide to participate. Athletes were assessed after returning their consent form to their coach. When consent forms were not returned, the primary researcher contacted the parent(s) by telephone to describe the study and invite participation.

Arrangements were made at one of the gyms to interview athletes there during practice time and parents of these children were informed of this arrangement when they received the consent form. Parents of children from the other three gyms were contacted by telephone and arrangements were made to assess the children in one of three possible settings: a) at the child's home; b) at the psychology department; c) at the gym.

Interviews were conducted either at the athletes' home or during practice time. In some cases the parents answered the APQ questions over the telephone, and in other cases they answered the questions in person at the time of the interview. Two research assistants, one male and one female, assisted in data collection. Twenty participants were administered the Stanford-Binet and cognitive developmental tasks by one of these trained assistants rather than by the primary investigator.

When the entire protocol was administered by the primary researcher (48 participants), the RAPI questions were administered first in order to ensure the interviewer had no knowledge of participants' cognitive developmental level or performance on the SB-IV subtests. Knowledge of this sort may have led to

expectancy effects for performance on the RAPI questions. The cognitive developmental tasks were presented between the RAPI and the SB-IV subtests as the cognitive developmental items were more interactive and allowed for a break from what was sometimes tedious questioning for participants. When the cognitive tasks and SB subtests were administered by a research assistant, they were completed either before or after the RAPI. The APQ was always administered last.

Building rapport. Prior to turning on the tape recorder, the interviewer established rapport by talking to the participant about interesting subjects such as sports, hobbies, movies, school or other activities. Once eye contact and rapport were established, easy-to-answer warm-up questions were presented before scored questions were asked, as suggested by Ross and Ross (1984b). The children were asked what they liked best about gymnastics and asked to give the reasons for their responses. This procedure allowed the interviewer to make sure the participants were comfortable being prompted for more information and in having to justify their responses.

Training of the interviewer. The interviewer practiced the interview procedure until she had full command of all the questions and prompts before questioning any of the final participants. The skill of the interviewer was determined and improved by evaluating tape recorded interviews with pilot participants.

Controlling for experimenter effects. The RAPI had standard prompts used with the questions, designed to ensure that every participant was interviewed in the same manner. When the entire protocol was administered by the primary

researcher, the SB, cognitive developmental, and APQ data were gathered following the RAPI ensuring that the interviewer was not influenced by knowledge of the participants' other scores. Every interview was audiotaped and then scored by a research assistant who was not present during the interview and who had no information on participants' age or performance on any of the other measures.

Addressing methodological issues. As discussed earlier in the sections on children's understanding of illness and of pain, previous studies have suffered from several methodological problems. The present study addressed these issues in the following ways: (a) Detailed descriptions of participants, assessment tools, and procedures are provided. (b) The interviewer was not aware of children's cognitive developmental level when conducting the pain interview. (c) Where possible, an assessment of the reliability and validity of the questions developed for this study was conducted.

Forming Composite Scores for Analyses

Prior to all analyses, several composite scores were formed by summing the standardized scores (z-scores) of two or more variables. The composites were developed by standardizing and adding the individual scores. The composites are presented in Table 4.2 and each has a mean of 0.00 and a standard deviation of 1.00.

The intercorrelations amongst the variables composing "pain experience" ranged from .49 to .86; Cronbach's alpha for the Pain experience composite was .86. The SB Pattern Analysis score correlated .68 with the SB Vocabulary score; Cronbach's alpha for the SB score composite was .74. Number of injuries

correlated .53 with number of injuries resulting in missed gym time. Surprisingly, there was no significant relationship between visits to a health care professional and the two injury values. This latter finding was probably the result of the fact that visits for any injury, sport-related or otherwise, were included. Cronbach's alpha for the Injury experience composite was .59.

Table 4.2 Variables comprising composite scores.

Composite name	Variables			
Pain Experience	Frequency of pain in practice	Intensity of pain in practice	Frequency of pain in meet	Intensity of pain in meet
Injury Experience	Number of injuries	Number of injuries resulting in missed gym time	Number of visits to health care professional for treatment of an injury	
SB Score	SB Vocabulary score	SB Pattern Analysis Score		

Grouping Participants

Previous researchers examining children's understanding of pain (Harbeck & Peterson, 1992) and illness (Perrin & Gerrity, 1981; Redpath & Rogers, 1984; Simeonsson et al., 1979) grouped their participants on an a priori basis with each group consisting of an age range of 2 to 3 years. Gaffney and Dunne (1987, 1988) stated that they grouped their participants by cognitive developmental level, but this grouping was made on the basis of age and presumed cognitive developmental level, rather than on an assessment of cognitive development. Although Harbeck and Peterson (1992) grouped their participants by age on an a priori basis, they also

conducted an assessment of Piagetian cognitive development. They found that the groups differed significantly from each other in terms of their cognitive developmental levels and performance on the dependent measures, but that there were no significant differences within their two-year age groups. They also found that the strength of the relationship between the dependent variables and age was not significantly different from the strength of the relationship between cognitive developmental level and the dependent variables. Therefore, they reported their results by age, with the explanation that the results reported by cognitive developmental level would be similar.

In the present study, there was no a priori grouping of participants. The original plan was to combine age groups based on cognitive developmental level as well as on age and then compare the strength of the relationship between the major dependent variables with age versus those variables with developmental level. If there was no significant difference in the strength of the relation between the major dependent variables and the two independent variables, and if age and developmental level were positively correlated, then results were to be presented according to age with the understanding that results reported by developmental level would be similar (Harbeck & Peterson, 1992). However, this original plan was not viable due to the lack of discrimination yielded by the cognitive developmental tasks (to be discussed later).

Since SB score and chronological age were positively correlated and did not differentially predict performance on any of the interview questions, the relationship between age, SB score, and number of different types of pain was used to form

groups. Number of different types of pain was chosen for grouping as it was expected that experience with a variety of pain types would result in a greater understanding of pain concepts. This reasoning reflected the idea that experience in a particular area makes a person more knowledgeable in that area (Brown & DeLoache, 1978). Thus, gymnasts having experience with more types of pain would be expected to also have a greater understanding of, for example, pain causality.

As can be seen in Figure 4.1, the means of the various variables did not follow identical developmental trends, but the figure provided support for combining certain age groups. Thus, the age groups were combined on the basis of the observed means in Figure 4.1 as well as on the need to have a minimum number of participants in each cell. More detailed results of the relationships amongst age, SB score, cognitive developmental level, and other variables are described in the Results section.

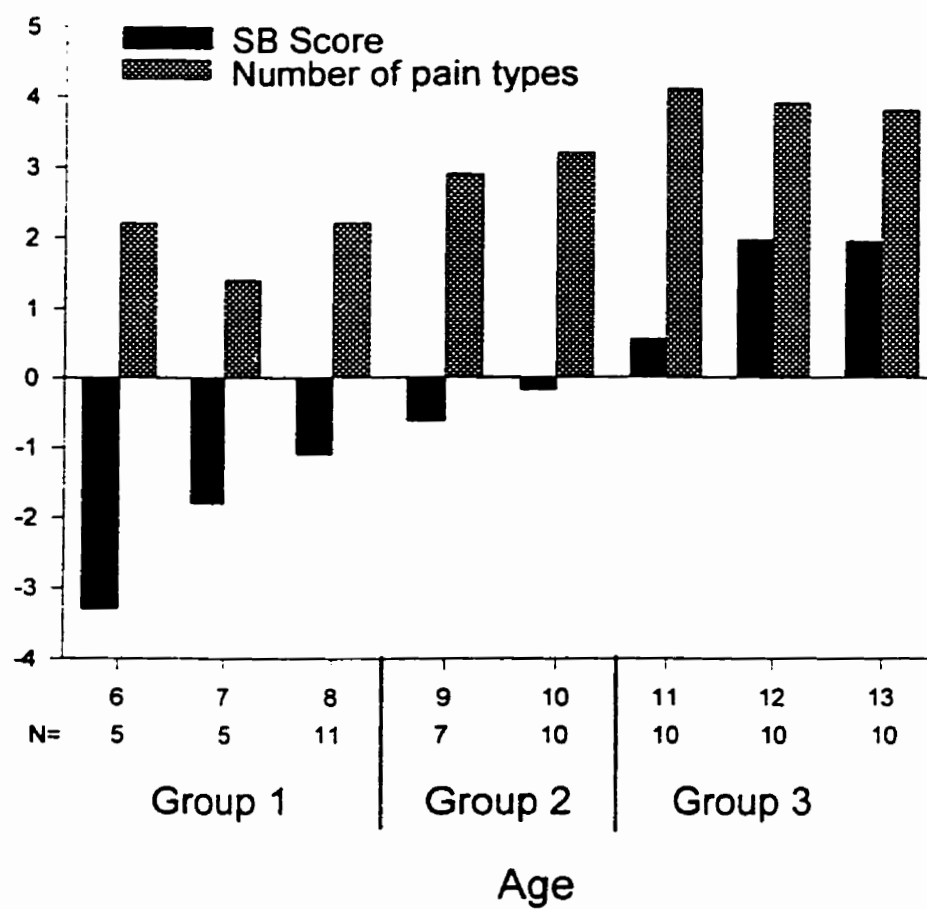


Figure 4.1. Relationship between age, SB score, and number of pain types identified.

Results

Both hypothesis driven and exploratory analyses were conducted on the data gathered in this study. In this section, the results of analyses performed to determine the reliability of the methods used to gather data will be discussed first, followed by the results of analyses driven by specific hypotheses. Last, the results of exploratory analyses will be presented. The exploratory section includes the results of RAPI questions regarding responses to pain and rationales for responding that elicited nominal data.

Reliability and Validity Issues

Reliability of the RAPI scoring system. Of the 68 interviews conducted, 15 (22%) were selected to establish the reliability of the RAPI. The procedure involved having 15 taped interviews scored by the primary investigator and comparing these results with those of the research assistant. The use of Cohen's (1960) kappa for assessing inter-rater reliability was discussed. However, since a large portion of the data reflected by the RAPI was nominal in nature, and in many cases participants were allowed multiple responses to one question, percentage agreement between the two scorers was calculated by counting the number of categories checked, the number of categories agreed upon between the raters, and then dividing the number agreed upon by the number checked. This procedure resulted in a percentage of agreement between the two raters ranging from 80% to 94% for the various questions. The agreement percentages for the questions are as

follows: Response to pain, 85%; Rationale for response, 82%; What happens to body, 88%; Injury definition, 80%; Understanding of pain causality, 87%; Understanding of value of pain, 88%; Secondary gain, 94%. These agreement percentages proved the scoring system to be highly reliable and the results produced by the research assistant were used in subsequent analyses.

Experimenter effects. As described earlier, some of the participants were administered the SB and cognitive developmental tasks by research assistants and others by the primary researcher. A one-way analysis of variance revealed no significant differences in the scores on the Stanford-Binet ($F = 2.04$) subtests nor on the cognitive developmental tasks ($F = .38$ for blocks omissions and $F = .55$ for blocks repetitions) as a function of the individual tester.

Recollection as a function of age. One method of determining whether recollection was associated with age was to compare the responses of the athletes to the responses of their parents on questions requiring memory. Questions 8 to 10 on the APQ asked participants the number of injuries they had in the past 12 months, the total number of injuries preventing them from participating in sport, and the number of visits they had made to a health care professional because of an injury. Overall, the parents' and children's scores correlated significantly: number of injuries in past 12 months, $r = .55$; number of injuries resulting in missed gym time, $r = .57$; number of visits to health care professional, $r = .33$. After forming the three age groups, each group was examined for correlations between the parents and children. There were some differences between the three age groups. For number of injuries in the past 12 months the correlations were: group 1 (ages 6-8), r

= -.21; group 2 (ages 9-10), $r = .80$; group 3 (ages 11-13), $r = .71$. For number of injuries resulting in missed gym time: group 1, $r = .93$,; group 2, $r = .94$,; group 3, $r = .44$. For visits to a health care professional: group 1, $r = .25$,; group 2, $r = .64$,; group 3, $r = .28$.

In some cases APQ questions 8 to 10 were asked with both the parent and child present, and the two collaborated on the answers. In other cases these questions were posed separately. This approach assumed that the parent was the more reliable source for this information. However, a number of parents remarked that the child was the better historian of such information. This response was more frequent for parents of children over the age of nine. The reasons the parents gave were that the children often did not tell them of every injury, or that they had lost track of their children's injuries.

As previously described in the section on forming composite scores, the injury experience composite was not internally consistent (Cronbach's $\alpha = .59$). This low reliability was probably due to the inconsistent correlations involving reported injury experience. Previous research (Peterson, Harbeck & Moreno, 1993) has found retrospective recall of injuries by mothers and children for even a six month time period to be inaccurate. Due to the inconsistency of the correlations described above, the injury experience variable was deemed unsuitable for use in further analyses.

One concern at the outset of this study was that the younger participants would be unable to recall any but very recent instances of pain. The implication of this concern was that the youngest gymnasts would not be able to discuss all of the

pain types they had experienced as they would have forgotten most of them. One of the questions on the APQ asked participants to think of "the most pain they had ever felt" and to describe what happened and how long ago it had happened. There were no significant differences between the age groups in terms of the reported length of the time that had passed since the event. Participants recalled events from between 1 to 90 months in the past. This result indicated that the younger athletes were not merely recalling their most recent experience with pain as opposed to their most pain ever. This result does not necessarily mean that reports of time were accurate, as they were not checked against parental reports, but it does indicate that even the youngest gymnasts were able to recall more pain events than only those that had happened in the recent past.

Motivational effects. It was important to attempt to determine the effects of motivation on participants' responses in this study. Of concern was the possibility that older participants would be motivated to respond to pain in ways different from younger participants solely due to the fact that gymnastics was so important to them. That is, rather than responding to pain because they had a greater understanding of pain types and what the pain signalled, they responded based on their "obsession" with their sport. This concern was generated by reports in the media of children participating in sport while forsaking all other interests. In this study, participants were asked to rate how important gymnastics was to them (see APQ question 6 in Appendix D) on a 127mm Visual Analogue Scale (VAS) scale ranging from 0 - "not important" to 127 - "most important thing I do." Results of a one-way analysis of variance revealed no significant differences between the age groups ($F = 1.22$).

The variability within each group was quite large. The minimums and maximums for each group were as follows: group 1, 21 -127mm; group 2, 55 -127mm; group 3, 22 - 126mm. During administration of this item, some of the participants remarked that gymnastics was quite important to them, but school and their friends were more important.

Results of Hypothesis Testing

Hypothesis 1) Relationship between chronological age, SB score and cognitive developmental level. It was hypothesized that cognitive developmental level (as measured by the Concept Assessment Kit (KIT) and Blocks tasks described earlier), SB score, and chronological age would (a) be positively correlated with each other, and (b) would not differentially predict performance on any of the interview questions. Part (a) of this hypothesis was tested by using Pearson product moment correlations. SB score and chronological age were highly correlated ($r = .85$, $p < .0001$). Although number of omissions and repetitions on the Blocks task was negatively correlated with both age and SB Score, only one of these correlations was significant. KIT scores correlated significantly with age ($p < .05$), but not with SB score. The correlations are shown in Table 5.1.

Part (b) of the above hypothesis was tested by first determining the strength of the relationship between the independent variables of chronological age, SB score, and cognitive developmental level with the dependent variables. It was obvious that age and SB score were strongly related to the dependent variables while cognitive developmental level was not (see Table 5.1.). The relationship between age and understanding of pain causality was maintained when a partial correlation controlling

for the effect of gender was conducted ($r = .48, p < .001$). Of the cognitive developmental tasks, the only significant correlations were between Blocks Omissions and understanding of pain causality ($r = -.26, p < .05$) and between KIT and value of pain ($r = .85, p < .05$).

Based on the results in Table 5.1, cognitive developmental level was not further considered in subsequent analyses. Although KIT scores correlated with age and pain causality, the KIT was administered to only seven participants (age 7.5 years and below) and was therefore excluded from further analyses. Reasons for the failure of the cognitive developmental tasks to discriminate performance on the dependent variables are considered in the Discussion section.

Age and SB score were highly correlated with each other ($r = .85$). Correlations of the dependent variables with age and SB score, respectively, were as follows: number of different pain types described ($r = .63$ vs. $.54$); injury definition ($r = .18$ vs. $.07$); pain causality ($r = .56$ vs. $.57$); number of good things about pain ($r = .49$ vs. $.49$). Except for injury definition, these correlations were significant ($p < .0001$). A comparison of dependent correlation coefficients was done using the formula prescribed by Cohen and Cohen (1983) which takes into account the fact that the coefficients come from the same sample. The comparison of coefficients revealed no significant difference in the strength of the relation between the major dependent variables with age versus those variables with SB score. Based on the above results, subsequent analyses were performed using age as the independent variable with the understanding that results using SB score as the independent variable would be similar.

Table 5.1. Pearson product moment correlations for the variables of chronological age, Stanford-Binet Score, cognitive developmental tasks, and dependent variables.

	SB Score	Blocks Omissions	Blocks Repetitions	Kit	Injury Definition	Pain Causality	Value of Pain
Age	.85**	-.17	-.07	.76*	.19	.56**	.49**
SB Score		-.27*	-.17	.51	.10	.57**	.49**
Blocks Omissions			-.22	+	.13	-.26*	-.20
Blocks Repetitions				+	-.22	.03	-.08
Kit + Injury Definition					.65	.15	.85*
Pain Causality							

+ The Concept Assessment Kit was administered to only 7 participants and was not used in combination with the Blocks tasks.

* $p < .05$

** $p < .01$

Hypothesis 2) Sex differences. The results of pain research concerning sex differences are conflicted (cf. Lautenbacher & Rollman, 1993). Research with children has revealed no sex differences on the variable of response to pain (cf. Bournaki, 1997). Sex differences were not expected to occur and were examined post hoc on a number of variables in order to provide support for the decision to collapse groups across sex.

Training time. Girls trained an average of 14 (sd = 6.7) hours per week while boys trained an average of 9.2 (sd = 5.2) hours per week. This difference was significant ($t = -3.05$, $p < .003$). The difference in training time may have to do with the different maturation rate of the two sexes in the sport of gymnastics. Female gymnasts peak in their early teens, while males peak in their early 20's. Table 5.2 shows the number of training hours by age group by sex.

Table 5.2. Participant training hours by sex by age.

Sex	Age	N		Minimum	Maximum	Mean
Male	6-8 years	5	Hours	4	4	4.0
	9-10 years	6	Hours	4	13	7.2
	11-13 years	14	Hours	4	18	12.0
Female	6-8 years	16	Hours	2	16	7.7
	9-10 years	11	Hours	10	25	16.7
	11-13 years	16	Hours	11	25	18.4

Importance of gymnastics. Participants' responses to the APQ item asking them to rate how important gymnastics is to them were examined for sex differences. On a scale of 0 to 127, mean rating for the girls was 104.9 (sd =

19.5) while for the boys it was 88.8 (sd = 28.8). A t-test revealed the girls to rate gymnastics as significantly more important to them than the boys did ($t = -2.27$, $p < .008$).

Most pain. Sex differences were also examined on the responses to the APQ item asking participants to rate the most pain they had ever felt. On a scale of 0 to 127 mean rating for the girls was 90.1 (sd = 21.6) while for the boys it was 81.2 (sd = 28.7). A t-test revealed no significant difference in these scores ($t = -1.43$).

Event leading to most pain. The responses to the APQ question asking participants what event led to the most pain they had ever felt were examined for sex differences. A cross-tabulation revealed a gymnastics-related event as the cause of "most pain" for 57% of the girls and 42% of the boys, while non-sport related events were described by 38% of the girls and 50% of the boys. Events occurring during other sports were described by 5% of the girls and 8% of the boys.

Number of different pain types identified. There was no significant difference in the number of different pain types identified by boys and girls ($t = -.40$). The girls identified a mean of 3.16 (sd = 1.2) types of pain while the boys identified a mean of 3.04 (sd = 1.2) types.

Pain descriptors. There was no significant difference between the boys and girls in the use of pain descriptors ($t = .03$). Both boys and girls had a mean of 1.9 (sd = 1.1) for this variable, indicating that their average response was the use of metaphor in describing how their pain felt.

Injury definition. Both sexes defined an injury in a similar manner ($t = .39$). Boys scored an average of 4.4 (sd = 1.1) for their responses, while girls scored an

average of 4.2 (sd = 1.4).

Understanding of pain causality. Boys' average response was 5.5 (sd = 2.1) while the girls' was 4.5 (sd = 2.4). Although the boys' responses were, on average, one full category higher than the girls', this finding was not significant ($t = 1.8$).

Understanding the value of pain. Girls described an average of 1.3 (sd = .85) good things about pain, while boys described an average of 1.6 (sd = .81). The difference between the sexes was not significant ($t = 1.8$).

Use of pain for secondary gain. Boys described an average of .72 (sd = .98) ways they had used pain for secondary gain while the girls described an average of .44 (sd = .63). This difference was not significant ($t = 1.4$).

Hypothesis 3) Number of different types of pain identified. A one-way analysis of variance with LSD post-hoc test revealed that each of the three groups differed significantly from each other ($F = 28.46$, $p < .05$) in terms of how many different pain types they identified. See Appendix C for a description of the different pain types. Children aged 6 to 8 years identified a mean of 1.9 (sd = .95) types of sport-related pain, those 9 to 10 years identified a mean of 3.1 (sd = .83) types, while those 11 to 13 years identified 3.9 types (sd = 3.9).

The younger children had no experience with pain due to stiffness the day following a work-out (type C) and little experience with pain due to serious acute injury (type F) or with chronic pain (type G). Groups 2 and 3 had much experience with pain due to exertion and almost half the group 3 participants had experience with serious injury. Half of group 3 participants reported chronic pain (type G).

The experience of momentary pain having little consequence (type D) was uniformly experienced by all age groups. See Table 5.3 for a summary of these results.

Table 5.3. Percentage of participants in each group identifying each pain type.

Pain Type	Age Group		
	1 (6-8 yrs)	2 (9-10 yrs)	3 (11-13 yrs)
B Exertion	62	100	93
C Stiffness	0	18	47
D Momentary	76	71	73
E Minor Acute	52	76	83
F Serious Acute	10	24	47
G Chronic	0	12	50

Hypothesis 4) The distinction between exertion and pain. After describing their experience with pain due to exertion (type B), participants were asked if they would call this type of sensation "pain." It was expected that the older participants would be less likely to describe sensations due to exertion as pain. Of the 53 gymnasts (10 from group 1, 17 from group 2, 26 from group 3) who had experienced sensations due to exertion, 31 of them said that they would definitely not call the feeling "pain" while 9 of them said it was, to paraphrase a common response "sort of pain, but not really." See Table 5.4. For the purpose of subsequent analyses, the participants saying "definitely not" and those saying "sort of" were summed. Forty of the 53 (75.5%) children did not consider the sensations due to exertion to be painful, at least not in the same way they considered other types of pain to be painful. This result was significant (Chi-square = 13.75, Significance = .0002).

Table 5.4 Responses to the question "Would you call that (physical exertion) pain?"

	Age Group		
	1 (6-8 yrs)	2 (9-10 yrs)	3 (11-13 yrs)
"Yes"	5	4	4
"No"	3	9	19
"Sort of"	2	4	3
N reporting	10	17	26

*Note: Not every participant reported an experience of pain due to exertion.

As indicated in the above table, 13 children did describe sensations due to exertion as painful: 5 from group 1 (50%); 4 from group 2 (24%); 4 from group 3 (15%). There was a trend toward a decrease in the number of exertion sensations described as painful with increasing age (Chi square = 4.69, $p < .09$).

Hypothesis 5) Rationales per response to pain. In answering RAPI questions concerning why they respond to pain in certain ways, older gymnasts were expected to consider more factors than were younger gymnasts. In order to examine this hypothesis, the number of rationales used by each athlete was counted and then divided by the number of pain types they discussed in order to compute a score reflecting the average number of rationales used per pain described. Next, a one-way analysis of variance and LSD post-hoc test of the number of rationales per pain by age were conducted. Results revealed participants from groups 2 and 3 (aged 9-13) used significantly more rationales to explain their responses to pain ($F = 5.9$, $p < .05$) than group 1 participants (aged 6-8). Average number of rationales per response for group 1 participants was 2.5 (sd = 1.5), while group 2 and 3 participants gave 3.5 (sd = 1.5) and 3.7 (sd = .84) rationales, respectively.

Hypothesis 6) Use of pain descriptors. Older athletes were expected to use

specific labels and metaphors when describing how their pain felt while younger athletes were expected to rely more on synonyms to describe pain sensations. After athletes had described their response to a type of pain, they were asked to describe how that pain felt (RAPI question 3). Their responses were recorded verbatim and were scored according to Table 5.5. This scoring system was taken from Harbeck and Peterson (1992) and the categories reflect a continuum of complexity and accuracy. The first category, use of a specific label, is the most complex.

Table 5.5. Scoring system for pain descriptors (based on Harbeck & Peterson, 1992).

Categories	Examples
1. Specific label	Sharp, dull, tingling, tight, stiff.
2. Metaphor	Like a wrench around my arm.
3. Intensity	It hurt more than the last one; It hurt really bad.
4. Synonym	Sore, tired, hurt, owie.
5. Don't know	

Mean scores for Groups 1 to 3, respectively, were: 2.6 (sd = 1.4), 2.0 (sd = 1.0), and 1.4 (sd = .44). A one-way analysis of variance and LSD post-hoc test revealed group 3 to be significantly different from group 1 ($F = 8.9$, $p < .05$).

This result indicates that the older children were significantly more likely to use specific labels and metaphors when describing how their pain felt compared to those aged 6 to 8 years. The younger children were more likely to rely on synonyms and/or appeal to the intensity of the pain when trying to describe how it felt as compared to the oldest gymnasts. All of the group 3 participants were able to describe their pain at least in terms of intensity, while some group 2 participants relied on the use of synonyms.

Hypothesis 7) Injury definition. Older athletes were expected to have more comprehensive definitions of injury than younger athletes. It was expected that when answering RAPI question 5, the athletes aged 6 to 8 years would not be able to define an injury, nor would they be able to describe what happens inside the body when a person has an injury or a "really bad hurt." Athletes aged 11 and older, however, were expected to describe damage to bones and body tissues when defining an injury. These older athletes were also expected to include the consequences of an injury (e.g., not being able to compete) in their definitions. This hypothesis was tested by assigning responses to RAPI question 5 to one of the categories determined during pilot testing (see Appendix C) and then comparing the three age groups with a one-way analysis of variance. This analysis revealed that the groups did not significantly differ in how they defined an injury ($F = 1.6, p > .05$). Among the 68 participants, 35 of their definitions were categorized as a specific type of identifiable damage (category 4) and 15 of them were categorized as a non-specific hurt, pain, fatigue, or sensation (category 3). Only eight participants defined an injury in terms of how it limited their activity (category 7).

Hypothesis 8) Understanding of pain causality. Older athletes were expected to display a more cognitively mature understanding of pain causality. It was predicted that the youngest participants would have trouble answering questions regarding causality of pain due to their limited cognitive capability in conceptualizing pain (Gaffney, 1993, 1988; Gaffney & Dunne, 1986, 1987; Harbeck & Peterson, 1992). This hypothesis was tested by first assigning responses to RAPI question 6 to a category (as described earlier, see Appendix C) and then performing

a 3-group one-way analysis of variance on the scores followed by cell comparisons ($F = 13.06$, $p < .001$). A LSD post-hoc test revealed group 2 and 3 to display a significantly ($p < .05$) more advanced understanding of pain causality than group 1, but not to differ from each other. The means for groups 1 to 3, respectively, were: 3.0 ($sd = 1.8$), 5.4 ($sd = 2.4$), 5.8 ($sd = 1.9$).

Of the 68 participants, 15 were able to describe the role of the brain and/or nerves in pain causation. None of the group 1 participants recognized the role of the brain and/or nerves in pain causation. Group 1 participants were most likely to name a body part indirectly involved in pain sensation, group 2 participants were most likely to describe the physiological event that led to the pain, and group 3 participants were most likely to describe the physiological event or describe the role of the nerves and/or brain.

Hypothesis 9) Understanding the value of pain. It was predicted that older gymnasts would identify more valuable aspects of pain. The older participants were expected to understand the value of pain as a sensation that provides information regarding the state of their bodies while younger athletes were not expected to be cognizant of any value of pain. RAPI question 7 asked participants what is good about pain. Responses to this question were placed into categories developed during piloting reflecting different values of pain (See Appendix C). A 3-group one-way analysis of variance followed by cell comparisons revealed group 2 and 3 participants thought of significantly more ($F = 9.62$, $p < .05$) good things about pain compared to group 1 participants but did not differ from each other. Means for groups 1 to 3, respectively, were: .86 ($sd = .65$), 1.4 ($sd = .70$), 1.8 ($sd = .85$).

Hypothesis 10) Secondary gain. Participants were expected to report using pain for secondary gain both in the context of gymnastics and at home or school. Further, they were expected to report using pain to account for poor gymnastics performance. With RAPI question 8, participants were asked if they had ever used pain for secondary gain, and, if so, what they gained. A count of the responses revealed that 19 group 3 participants (63%), 7 group 2 participants (41%), and 2 group 1 participants (.10%) had used pain for secondary gain. These numbers represent 41% of the total sample. Some of the group 3 participants had used pain for secondary gain multiple times. A one-way analysis of variance with LSD post-hoc test revealed group 3 participants to describe significantly more instances of pretending they had pain for secondary gain than group 1 or 2 participants ($F = 9.27, p < .05$). Means were as follows: group 1, .10 (sd = .30); group 2, .41 (sd = .51); group 3, .93 (sd = .94).

The responses to question 8 were further broken down to differentiate between the use of sport-related and nonsport-related pain for secondary gain. Sixteen participants reported the use of sport-related pain for secondary gain while 11 participants reported the use of pain from other sources (e.g., headache) for similar gain. No gymnast said they had used pain to account for a poor performance. Six gymnasts from group 3, however, said that they had pretended they were in a lot of pain to avoid doing something that they were scared of in the gym.

Hypothesis 11) Prediction of understanding of pain causality. It was hypothesized that the variables of number of training hours per week, injury

experience, and number of different pain types identified would predict pain causality scores. With each participants' pain causality score serving as the dependent variable, a step-wise multiple regression was planned to determine if any of the above three variables predicted understanding of pain causality after the effects of age were accounted for. However, there were high correlations found between the proposed variables and age. Conducting multiple regression with highly correlated variables will not produce useful data since any one variable could be shown to account for the majority of the variance in the dependent variable. Thus, the multiple regression analysis was not conducted.

Hypothesis 12) Cognitive techniques. Older athletes were expected to mention the use of cognitive coping strategies to control pain more frequently than younger athletes when asked what they do in response to pain. However, crosstabulation revealed that two participants in each age group responded to pain by using some type of cognitive technique.

Hypothesis 13) Degree of danger posed by gymnastics. Although this study was not designed to determine the relative danger level of gymnastics compared to other activities, each participant was asked to describe the situation in which they had felt the "most pain ever." These responses were coded as 1) gym-related, 2) other sport-related, and 3) non-sport related. An incident at gym was described by 52% of the participants while non-sport related incidents were described by 42% (see Table 5.6). Only 4 participants mentioned another sport as the context for their "most pain ever." However, many of the participants had gymnastics as their sole sport or were participating only casually in other sports.

Table 5.6. Percentage of each age group endorsing each type of event resulting in "most pain ever."

Event	Age Group		
	1 (6-8 yrs)	2 (9-10 yrs)	3 (11-13 yrs)
Gymnastics	33	47	63
Other sport	5	0	10
Non-sport activity	57	47	27

Over 60% of the group 3 participants described a gym-related event as causing their most pain, while over half the group 1 participants described a non-sport related event. This latter result may be due to the fact that older participants spent much more time in the gym than the younger participants and, therefore, did not have as much time for other activities. The group 2 participants were evenly split between gym-related and non-sport related incidents.

Exploratory Analyses

Some of the RAPI questions elicited responses that, due to their complexity, could only be handled in an exploratory fashion. Thus, these data were explored in a manner not leading to any solid conclusions, but in a manner which may direct future research.

Exploration 1) Responses to the different pain types. Of interest was how athletes responded to pain and whether different types of pain resulted in different responses. The various responses to each of the pain types were crosstabulated. The crosstabulation procedure allowed a count of instances of a particular response by age group. Since reporting the results of each of 13 responses for 6 types of pain would be overwhelming, reported here are responses used most frequently by

the participants for each type of pain.

The majority (42 out of 68) of participants reported that they would continue in sport with pain due to exertion (type B). Only 13 of the 21 participants in group 1 had experience with this type of pain, while all of group 2 participants and 28 of 30 group 3 participants had experienced exertion pain. Roughly half of group 3 participants reported that they would continue with this pain due to exertion while a third of group 1 and 2 participants said they would continue. Only 4 of the participants said that they decreased the intensity of their workload during this type of pain, and only 3 participants (2 from group 1 and 1 from group 2) said that they told their coach.

Only 17 of the 68 participants reported muscle stiffness (type C) the day following a work-out, 3 from group 2 and 14 from group 3. Eleven of them reported that they continued gymnastics when experiencing that type C and 9 reported treating it themselves by doing something like stretching.

Fifty participants reported momentary pain having little consequence (type D), and the majority of them (43) continued gymnastics with this type of pain. This number (43) includes 5 participants (from group 2 and 3) who reported that they would respond to the pain, but only after they had completed whatever event/exercise they were doing. Two participants from the older age groups reported using a cognitive technique to deal with this pain and no participant reported decreasing the intensity of their workload. Roughly half of the participants in each age group reported treating the pain on their own, while more participants in group 1 reported telling their coach and taking a short break when they had

momentary pain.

Pain due to a minor acute injury (type E) was reported by 49 of the participants: 11 from group 1, 13 from group 2, and 25 from group 3. The majority of each age group, 6, 11, and 15 respectively, made some response to the pain and then continued in gymnastics. Only 4 of the participants (all from group 3) ignored the pain until they finished what they were working on. Eighteen of group 3 participants and 5 of the group 2 participants reported switching their physical activity. Physical treatment by self (e.g., ice, stretching) was reported by 6 group 1 participants, 13 group 2 participants, and 23 group 3 participants. Most of the participants (35) reported telling their coach about the pain: 5 from group 1, 11 from group 2, and 19 from group 3. Seeking professional treatment was reported by more of the older participants: 1 from group 1, 6 from group 2, and 14 from group 3. Taking a short break was popular for the younger participants: 8 from group 1, 5 from group 2, 7 from group 3. Two participants, one from group 1 and the other from group 2, reported using a cognitive technique to help them deal with the pain.

Twenty participants reported experiencing a serious acute injury (type F): 2 in group 1; 4 in group 2; and 14 in group 3. All of the participants reported that they stopped what they were doing and made some response to this type of pain. Of the 20 participants reporting this type of pain, 17 of them said they received physical treatment, such as ice, by either themselves or by their coach. Professional treatment was sought by 18 of the participants, and 11 of them quit training after experiencing such pain. Six of the participants said they kept training, but switched

their activity or changed their technique. Most of the participants (14) said that they took 2 or more days off from gym.

Chronic pain (type G) was reported by 17 participants: 2 from group 2 and 15 from group 3. Nine of the participants had received professional treatment for this pain at some point in the past. In response to this pain while training, 10 participants reported switching their physical activity (e.g., move to an apparatus that did not exacerbate pain) and 12 reported treating the pain on their own by doing something like applying ice or doing strengthening exercises. Only one participant reported treatment by a coach, thus, these young athletes said they knew enough about their condition to treat their own pain. Nonetheless, 9 of the participants reported that they do tell their coach when they have chronic pain. Often, the coach was told in order to explain why a certain exercise was not being done.

In summary, most participants continued gymnastics with pain due to exertion, muscle stiffness, or momentary pain (types B, C, and D) without stopping to apply treatment. With minor acute injuries (type E), the majority of participants received from their coach or applied themselves treatment and then continued gymnastics. Participants also tended to change their physical activity when having pain from a minor acute injury. When experiencing pain from serious acute injuries (type F) participants stopped what they were doing in order to treat the pain, and the majority of them also reported taking 2 or more days off from the gym. Chronic pain (type G) was responded to with some sort of treatment (e.g., ice or heat), usually by the athlete him or herself, or the athlete switched activities such that further pain exacerbation was prevented.

Exploration 2) Rationales for responses to pain. In answering RAPI questions concerning why they respond to pain in certain ways, older athletes were expected not only to consider more factors, but to be more motivated by the potential consequences of their actions than were younger athletes. Further, older athletes were expected to provide more rationales reflecting their greater knowledge of both injury prevention and achieving a training effect. In order to examine these hypotheses a number of steps were taken. First, a count of the use of each rationale was conducted and crosstabulation used to determine the incidence of the use of each rationale by age group (Table 5.7). Please refer to the RAPI interview (Appendix C) for a more complete explanation of each rationale.

As can be seen in Table 5.7, some rationales were used much more than others by all participants, while some were used more by certain age groups. It was common for many participants, especially the youngest ones, to say "I don't know" when asked why they responded to pain in a certain way. However, with prompting, most participants were able to provide a rationale for their responses, even if it was just to say "because it hurt."

Rationale 4, "not serious" was often used to justify continued training despite pain. Participants from all age groups frequently believed that they were able to judge when their pain was of a minor nature. Almost all rationales were used by a higher percentage of group 3 participants, followed by group 2 participants. This finding reflects the fact that older participants used more rationales per response than younger participants, and had more pain types to talk about. The exception to this pattern is seen in rationale 21, "end of session." This rationale was used somewhat

more frequently by younger participants to explain why they stopped training.

Table 5.7. Percentage of participants in each age group using each rationale in descending order of frequency.

Rationale	Age Group		
	1 (6-8 yrs)	2 (9-10 yrs)	3 (11-13 yrs)
11 Desire to compete/train	48	35	47
4 Not serious	62	76	80
15 Reduce/prevent pain	57	82	80
2 Reaction to pain	43	82	83
16 Prevent damage	38	65	90
14 Make a physical change	24	59	87
6 Adult can help	48	53	60
5 Adult decision	24	59	60
7 Professional advice	10	41	77
1 Don't know	62	35	37
10 Conditioning effect	5	18	33
21 End of session	14	18	7
20 Determine severity	0	12	10
18 Affecting performance	5	0	10
8 Unimportant meet	0	0	10
12 Part of sport	5	0	7
13 Pressure from others	0	0	10
17 Save self for future	0	0	7
19 Mental state	0	0	3
3 Didn't want to tell	0	0	3
9 Important meet	0	0	0

One reason for this latter finding is that younger participants may be more prone to hurting themselves at the end of a practice. That is, their ability to concentrate may be more prone to decline after time in the gym. Another possible reason is that younger participants were less motivated to continue training if they hurt themselves near the end of a practice. In either case, it makes sense that older athletes are both more motivated to use all of their training time to full benefit and are more aware that they are fatigued near the end of training and, thus, are careful in the movements they attempt.

Since there were 6 types of pain, 13 possible responses, and 21 possible rationales, it would have been uninformative to consider every possible combination of pain type, response, and rationale. For example, rationale 10, "to achieve a conditioning effect" would not be used to describe why one would stop training. Certain combinations of response and rationale simply did not make sense. Therefore, the following paragraphs focus on combinations of responses and rationales that were expected to co-occur. These combinations were counted and crosstabulation used to look at the number of uses of each rationale for each age group.

Exploration 3) Understanding the need for differential responses. The first rationales examined were chosen as they helped to determine whether young athletes understand why they respond to different pain types in different ways. At the outset, this study was designed to determine whether athletes could make distinctions between three types of pain: (a) that due to a conditioning effect (training pain); (b) that due to an injury requiring some immediate attention (injury pain); and (c) pain

reflecting a more minor injury (warning pain). In this study, type B (exertion) pain was obviously training pain while injury pain was type F (serious acute injury). Types C, D, and E (muscle stiffness, momentary pain, and minor acute injury) all reflected warning pain (pain E was most difficult to define). See Appendix C for a complete description of the pain types. Of the 21 rationales, 4 reflected knowledge of conditioning effect and injury prevention. These rationales, along with the number of participants using them for each pain type, are listed in Tables 5.8 to 5.11.

Table 5.8 displays the use of rationale 4, "Not serious, or nothing can be done" for each pain type. For type B pain (exertion), approximately one third of all the participants having experience with this pain responded to the pain based on the belief that it was not serious. Although only 13 out of 21 group 1 participants had experienced pain due to exertion, a third of them already knew that this sensation was not a signal of danger.

Very few participants reported having type C pain (muscle stiffness). Seven participants from groups 2 and 3 understood that type C was not an indication of a serious injury and that there was really nothing they could do to address this type of pain. Other participants did report doing things like stretching in order to try to reduce the pain or loosen up their muscles.

It is interesting to note the high percentage of participants across ages using rationale 4 (not serious) with type D pain (momentary pain). Rationale 4 was used to explain why they would continue with pain and the results show that the participants understood that there is a type of pain, not due to conditioning, that is

also not indicative of an injury requiring attention. Type D is one of the "warning pains" and while it was expected that the older participants would use rationale 4 (not serious) to justify their response to it, the high degree to which it was used by the group 1 participants was surprising.

Table 5.8. Percentage of participants in each age group using rationale 4, "Not serious or nothing can be done," for each pain type.

Pain Type	Age Group		
	1 (6-8 yrs)	2 (9-10 yrs)	3 (11-13 yrs)
B Exertion	31	29	39
C Stiffness	-	67	36
D Momentary	69	50	77
E Minor acute	9	31	32
F Serious acute	-	-	-
G Chronic	-	50	40

Note: not all participants experienced each type of pain.

Rationale 4 (not serious) was not used as much for type E (minor acute injury) as it was for type D (momentary). This was as expected since type E pain is more severe. About a third of group 2 and 3 participants regarded type E as not serious and used rationale 4 to justify their response to it. Of the 11 group 1 participants having had type E (minor acute injury), only 1 of them stated that it was "not serious." This latter finding revealed that the youngest participants tended to view type E pain as more severe than the older participants. This may be due to the older participants having had more experience training with type E pain (minor acute injury) as well as having more experience with more severe pain. As mentioned previously, type E was the most difficult pain to classify as it hovered between types D (momentary) and F (serious acute injury). Thus, some of these type E pains

were, indeed, "not serious" while others may have been more threatening.

Rationale 4 (not serious) was not used at all for type F pain (serious acute injury). This is an important and encouraging finding as it provides evidence for the idea that participants of all ages understood that pain due to a severe injury is a serious concern.

For about half the participants having experience with chronic pain (type G), the rationale that there was nothing to be done about it or that the pain was not serious, was used. In some cases it is true that training with chronic pain will not exacerbate the condition. However, to continue training with chronic pain may result in more serious pain and injury, especially in children (Caine & Lindner, 1990a). While only 17 participants had experience with chronic pain, and most of them treated the pain in some way, they did continue to train with the pain. This may be a situation where the child relies on adults such as coaches, parents, and health care professionals in deciding whether or not to continue in sport despite pain. Obviously, many children are highly motivated to train through pain, but might not do so if they were told not to by adults. Since training with a chronic pain condition may or may not worsen the condition, adults are in a difficult situation when deciding what the young athlete should undertake.

Table 5.9 shows that approximately 35% of all participants who had experience with pain due to exertion (type B) used the rationale "to achieve a conditioning effect" to justify their response to this pain. In contrast, this rationale was rarely used to justify responses to the other types of pain, indicating that the participants understood that these other pain types do not signal a conditioning

effect. When rationale 4 (not serious) was used with types C - G, participants explained that they would continue training with these pain types because they wanted to get stronger. For example, a participant with a leg in a cast may come to the gym to do conditioning work to gain upper body strength and endurance.

Table 5.9. Percentage of participants in each age group using rationale 10, "To achieve a conditioning effect" for each pain type.

Pain Type	Age Group		
	1 (6-8 yrs)	2 (9-10 yrs)	3 (11-13 yrs)
B Exertion	31	29	39
C Stiffness	-	-	7
D Momentary	-	-	5
E Minor acute	-	-	4
F Serious acute	-	-	14
G Chronic	-	-	7

Table 5.10 illustrates the number of participants using rationale 15 "to reduce/prevent further pain" in response to the different pain types. The most striking finding in Table 5.10 is the high percentage of participants who justified their responses to pain types D - F with the rationale "to reduce/prevent further pain." For the most part, participants recognized that there were things they could do to prevent or reduce pain. Group 3 participants used this rationale less than the other groups for type D (momentary), probably because these more experienced athletes tended to ignore this pain more than the younger participants, as described previously. Only about half of the participants having chronic pain (type G) responded to this pain so as to reduce it, reflecting their knowledge that in many cases there is nothing they can do to reduce this pain. It is somewhat surprising that

rationale 15 (to reduce/prevent further pain) was not used more by groups 2 and 3 for type F (serious acute injury), but this may be due their more frequent use of rationale 16, as described next.

Table 5.10. Percentage of participants in each age group using rationale 15, "To reduce/prevent further pain," for each pain type.

Pain Type	Age Group		
	1 (6-8 yrs)	2 (9-10 yrs)	3 (11-13 yrs)
B Exertion	15	29	29
C Stiffness	-	67	21
D Momentary	44	67	27
E Minor acute	64	69	68
F Serious acute	50	25	29
G Chronic	-	-	53

Only one participant responded to type B pain (exertion) with the intent of preventing further damage (see Table 5.11). This result reveals that, for the most part, the athletes recognized that the pain from exertion does not signal impending or actual injury.

Two athletes used rationale 16 to justify their response to type C pain (stiffness), indicating that, again for the most part, the athletes knew that muscle stiffness the day after a work-out will not develop into a more serious injury. Looking at type D (momentary), it is evident that athletes of all ages are aware that even very minor pain may become more serious if not responded to in some manner. Athletes were equally aware of the necessity to respond to types E (minor acute injury) and F (serious acute injury) so as to prevent further damage. Roughly half the 17 participants having had chronic pain (type G) responded to it in a way to

prevent further damage.

Table 5.11. Percentage of participants in each age group using rationale 16, "To prevent further damage," for each pain type.

Pain Type	Age Group		
	1 (6-8 yrs)	2 (9-10 yrs)	3 (11-13 yrs)
B Exertion	-	6	-
C Stiffness	-	33	7
D Momentary	69	50	77
E Minor acute	45	77	68
F Serious acute	50	50	71
G Chronic	-	-	60

Summary of exploration 3 findings. The purpose of exploration 3 was to determine whether the athletes understood why they responded to different pain types in different ways. This exploration revealed that even the youngest athletes were able to justify their responses to pain depending upon the implications of having each type of pain. The rationale "Not serious or nothing can be done" was used by the majority of participants for pain due to exertion (type B). One third of the youngest participants understood this type of pain to be non-threatening. Rationale 4 (not serious) was also used frequently for momentary pain (type D) but not for acute injuries. This result indicates participants felt they could judge when a pain was "not serious."

"To achieve a conditioning effect" was used almost exclusively to justify a response to pain due to exertion (type B). This result indicates the participants not only understood the purpose of exerting themselves, they also understood that pain due to an acute or chronic injury did not signify an improvement in physical

condition.

"To reduce/prevent further pain" was used a great deal to explain responses to pain due to acute injuries and to chronic pain. Athletes understood that there were things they could do to eliminate their pain in these circumstances.

"To prevent further damage" was used by only one participant to explain a response to pain due to exertion. Participants understood that pain due to exertion did not signal damage to their body requiring attention. This rationale was used a great deal for pain due to acute injuries, indicating that the athletes were aware that there were things that could and should be done to prevent damage to their bodies.

In the following paragraphs results of other counts and crosstabulations with some of the rationales are presented. These rationales were chosen because they were most reflective of participants' ability to understand the consequences of participating in sport despite various types of pain.

Exploration 4) Adult advice for chronic pain. To a large extent when justifying their responses to chronic pain, the gymnasts appealed to their belief that adults were an authority on chronic pain. A count of rationales 5 (adult decision), 6 (adult can give help) and 7 (professional advice) revealed that of the 17 participants having experience with chronic pain, 12 of them used at least one of these rationales for their response to chronic pain. A count of rationale 7 revealed that 9 of the participants sought advice from a health care professional.

Exploration 5) Training despite pain. The use of rationales 15 and 16, to reduce/prevent further pain or damage, respectively, was described above. It seemed important to compare these future oriented rationales to the use of rationales

reflecting a more current focus. To this end, the use of the following rationales was counted: desire to compete/achieve goals (11), receiving pressure from others to continue (13), the importance of a meet (9), or that pain is simply a part of sport (12). Only three of group 1 participants, three of group 2 participants, and 13 of group 3 participants used one or more of these rationales to justify their responses to acute injuries and chronic pain (types E, F, and G). It seems that the athletes in this study were more likely to think of the future consequences of their pain (Tables 5.10 and 5.11) rather than focusing on the importance of training or competing.

Separate crosstabulations for a minor acute injury (type E), a serious acute injury (type F) and for the less severe types of pain (B, C, and D) were conducted using the above four rationales. These analyses revealed that rationales 9, 11, 12 and 13 (all focusing on future consequences of pain) were not used at all to justify a response to a serious acute injury (type F), but were used to justify responses to a minor acute injury (type E) by 3 group 1 participants, 3 group 2 participants, and 11 group 3 participants. This finding is important as it reveals that gymnasts are able to judge when the cost of continuing sport may outweigh any benefits received from continued training or competing. Further, the gymnasts understood that, unlike less severe types of pain, pain from a serious acute injury is not simply "part of the sport." Although it was sometimes difficult for the coders to decide between pain type E and F (minor and serious acute injury), it appears that one of the differences is that type F prohibits continuation in sport.

Nine of group 1, 5 of group 2, and 8 of group 3 participants used rationales 9, 11, 12 and/or 13 (desire to compete/achieve goals, receiving pressure from others

to continue, the importance of a meet, or that pain is simply a part of sport) to justify their responses to pain types B (exertion), C (muscle stiffness) and D (momentary). The number of athletes using these rationales for the less serious pain types is very similar to the number for type E (minor acute injury), again highlighting the idea that in some cases the benefit of continued training or competing outweighs the costs of continuing with these types of pain.

Even very young participants understood that some types of pain were simply part of gymnastics. One six-year-old girl, when asked why she would "try to tough it out" in response to type D (momentary) pain said "Because if you burst out and cry, you're not being tough at all, and if you're not tough, why should you be in gym? Because gym's about being tough, strong, and things like that."

Exploration 6) Seeking health care. It was expected that all the athletes would recognize the need to seek advice from a health care professional when faced with a serious acute injury (type F). There were 20 participants having had experience with type F pain and 12 of them stated that they did seek professional advice. There were a number of reasons why more participants did not seek health care: 1) a few of them had parents who were physicians, nurses, or physiotherapists, and these adults often decided that their child did not require further assistance; 2) some of them had similar injuries in the past and knew how to care for it on their own; 3) some received help from their coaches, who, while not health care professionals, had experience dealing with a wide range of injuries.

Exploration 7) Pressure to train/compete. One of the arguments of those concerned with young athletes training despite having severe injuries is that the

children put winning or meeting training goals ahead of caring for injuries. In this study, however, not a single gymnast stated that he or she would continue in sport with a serious acute injury (type F) because of wanting to compete, achieve goals, being pressured by others or because pain is simply a part of the sport. Further, when the other types of pain were examined, in only three cases did an athlete mention feeling pressured by others to continue gymnastics with pain.

Exploration 8) Preventing damage by changing technique or with physical treatment. When rationalizing their responses to pain, many athletes across all age groups described wanting to make a physical change (e.g., reduce swelling) and wanting to reduce/prevent further pain or damage (see Table 5.7). It seemed reasonable that athletes of different ages may choose to respond to pain in different ways in order to make a physical change or to prevent further pain or damage. That is, although all gymnasts may want to prevent pain and injury, those at different ages may have different methods of attaining this goal. The idea that younger athletes may rely more on physical treatment by themselves or their coach (responses 5 and 6) and older athletes rely more on switching or decreasing the intensity of their activity (responses 3 and 4) to prevent pain and injury was explored by first counting the incidence of rationales 14, 15, and 16 (preventing further pain/damage) associated with responses 3 and 4. In this context, rationales 14-16 were used by 1 group 1 participant, 8 group 2 participants, and 17 group 3 participants. Compared to group 1 and 2, group 3 participants understood to a greater extent that they could prevent pain and injury by changing their physical activity to make it less strenuous or by changing their technique.

The occurrence of the same rationales (14-16) to explain physical treatment by themselves or by their coach (responses 5 and 6) was counted. In this context, rationales 14-16 (preventing further pain/damage) were used by 13 group 1 participants, 15 group 2 participants, and 29 group 3 participants. It appears that even younger participants understood the role of direct physical treatment, such as ice or stretching, in the management of pain. As gymnasts get older, they learn that there are other things they can do, such as changing their physical activity, to reduce pain and prevent injuries. However, older gymnasts continue to rely on direct physical treatment in addition to adjusting their training technique in order to prevent pain and injury.

Exploration 9) Reaction to sensation as a rationale for response to pain. A very concrete reason for responding to pain is that "it hurts." A count of the use of rationale 2 (reaction to sensation) was conducted across pain types. Crosstabulation revealed 9 (43%) of group 1 participants, 14 (82%) of group 2 participants, and 25 (83%) of group 3 participants to use this rationale for their response to pain. A one-way analysis of variance followed by LSD post-hoc tests revealed significantly ($F = 4.3, p < .02$) more participants from Groups 2 and 3 used rationale 2 than participants from group 1. The large percentage of older participants using this concrete rationale may appear surprising. However, as described earlier, older athletes used more rationales per response than the younger athletes. Thus, older athletes combined the concrete rationale with more advanced ones.

Exploration 10) Reliance on adults. The extent to which the gymnasts relied on their coach and/or parent to address their pain was explored. The use of

rationale 6 (adult can give help) across all pain types was counted. Crosstabulation revealed 10 (48%) group 1 participants, 9 (53%) group 2 participants, and 18 (60%) group 3 participants used rationale 6 to explain why they would tell an adult about their pain. A one-way analysis of variance revealed that the groups were not significantly different from each other ($F = .56$). Rationale 6 reflects a very basic understanding of why it is important to tell an adult about pain. Rationale 15, reduce/prevent further pain, on the other hand, is a more advanced rationale for telling an adult about pain. The older athletes did use the basic rationale of "adult can give help" just as often as the younger athletes, but, as described earlier, they combined this basic rationale with more advanced rationales.

Exploration 11) Expected effects of continuing gymnastics with pain. With RAPI question 3 the participants were asked what would happen to their painful body part if they continued to train with each type of pain. Although gymnasts may or may not choose to continue with certain types of pain, RAPI question 3 was designed to determine specifically if they understood the potential physical consequences of their decisions. The responses to this question were coded according to the descriptions shown in Appendix C. Participants were allowed to say a maximum of three things that might happen to their body. Below are reported the most popular responses for each type of pain. Responses endorsed by 6 or more participants are included.

The most popular response for what would happen if gymnastics continued with type B (exertion) is that a conditioning effect would be achieved. There were 58 participants having had experience with this type of pain, and 20 of them

appreciated the physical gains this feeling of exertion signalled. However, 15 participants stated that the pain could intensify or recur and 10 said that damage could occur or worsen if they continued with type B pain. Given that participants were allowed to mention three things that might happen to their body, it is possible that they described achieving a conditioning effect as well as having more pain or an injury.

There were 17 participants having had experience with type C pain (muscle stiffness), and 6 of them stated that nothing would happen to their bodies if they kept training with this type of pain. The categories of pain intensifying/recurring and damage intensifying/recurring were each used 3 times.

Most (50) participants had experience with type D pain (momentary), and 27 stated that nothing would happen to their body if they continued with that type of pain. Sixteen of them said that the pain could intensify or recur, while 11 of them said that damage could occur or worsen if they continued gymnastics with type D pain.

Of the 49 participants having had type E pain (minor acute injury), 33 said that if they continued training with it damage could occur or the present injury could get worse. The consequence of pain intensifying or recurring was used by 24 of the participants, 10 of them said that nothing would happen to their body, and 6 said that the body part would take longer to heal.

There were 20 participants having had experience with type F pain (serious acute injury) and 14 of them said that damage to their body would occur or worsen if they continued gymnastics with that type of pain. Ten participants said that the

pain would intensify or recur if they continued.

Type G pain (chronic) was experienced by 17 participants. Nine of them said that damage would occur or worsen, 7 said that the pain would intensify or recur, and 6 said that nothing would happen to their body if they continued with this type of pain. Some of the participants stated that although pain might increase, they were aware from experience that they would not be making their condition worse.

Due to the large number of possible expected effects it was difficult to look at age differences in the expected effects of continuing gymnastics with each of the pain types. Table 5.12 illustrates age differences in expected effects of continuing gymnastics with pain types B (exertion) and F (serious acute injury).

Table 5.12. Number of participants endorsing each "expected effect" of continuing with pain types B (exertion) and F (serious acute injury) by age group.

Expected effect	Age Group					
	1 (6-8 yrs)		2 (9-10 yrs)		3 (11-13 yrs)	
	B	F	B	F	B	F
1) Don't know	1	0	1	0	0	1
2) Nothing	2	0	6	0	5	0
3) Enhances performance	0	0	0	0	0	0
4) Conditioning effect	3	0	6	0	12	0
5) Body fatigues	1	0	2	0	2	0
6) Pain intensifies	6	0	2	3	7	7
7) Damage	1	2	4	4	6	8
8) Longer to heal	0	0	0	0	1	3
9) Interferes with performance	0	0	0	0	0	0

Note: Not all participants had experience with each type of pain.

There were only 2 participants aged 6-8 having had experience with serious acute injury (type F) and they both believed that damage may intensify or recur if they continued with that type of pain. Likewise, participants from the other two age groups believed that pain or damage to their bodies may intensify or recur if they continued with pain due to a serious acute injury. All participants had a variety of beliefs about what may happen to their bodies should they continue with pain due to exertion. Even the youngest participants described achieving a conditioning effect as the result of pain due to exertion.

Exploration 12) Value of pain. Table 5.13 illustrates the results of a count of the use of 5 "good things" about pain followed by crosstabulation by age group. The most striking finding revealed by Table 5.13 is the large number of participants from all groups who said that pain was a good thing when it lets them know that they have been working hard. Participants tended to clarify this view of pain by stating that the sensation they described as a signal of hard work was not painful in the same way pain from an injury was painful. That is, they would describe having sore muscles or feeling exhausted as a signal of hard work. Nonetheless, many of them did state that knowing that they worked hard was one value of pain.

Category 4 was used sparingly by the athletes. Some of the things athletes said that fit into this category were: "You get tougher. If you have a lot (of pain) the little ones don't hurt so much."; "If you get used to it (the pain), you can handle it in a competition."

Category 5 goes beyond category 3 as it includes the knowledge that the athlete has not only worked hard, but has also made an improvement in his/her

physical condition. This category was mentioned much more by group 3 participants compared to the other groups, suggesting that as athletes get older and have more experience with exertion, they recognize that this particular type of pain does lead to physical gain.

Table 5.13. Percentage of participants in each age group using the various value of pain categories.

Category	Age Group		
	1 (6-8 yrs)	2 (9-10 yrs)	3 (11-13 yrs)
3) Signal of hard work	57	76	70
4) Increases tolerance for physical/mental pain	5	12	13
5) Signals an improvement in physical condition	-	6	37
6) Can use it for secondary gain	5	6	20
8) Signals a warning to stop or take some action	19	35	40

Note: categories 2 and 7 were not used by any participant and category 1 reflected "don't know" or a non-response.

Very few participants mentioned the opportunity for secondary gain as a value of pain. In fact, category 6 was used by only 8 of the 68 participants.

Approximately one third of the participants recognized pain's value as a signal to stop activity and/or check and see what is wrong. As will be discussed below, this result is quite different from that found by Harbeck and Peterson (1992), who found that even college freshmen did not see the diagnostic value of pain.

Summary of selected results

Influence of age. There were significant correlations between age and the following variables: (a) number of pain types identified; (b) type of pain descriptor

used; (c) understanding of pain causality; and (d) understanding of the value of pain. This result demonstrates a developmental sequence in the understanding various pain concepts.

Sex differences. T-tests revealed girls to train for more hours per week and to see gymnastics as more important than the boys. Crosstabulation revealed that the girls' "most pain ever" was most likely caused by a gymnastics-related event while the boys' was caused by a non-sport related event.

Distinction between exertion and pain. Of the athletes having experience with physical sensations due to exertion, 75.5% did not consider the sensations to be painful, at least not in the same way they considered other types of pain to be painful. This result was significant (Chi-square = 13.75, Significance = .0002).

Pain descriptors. Compared to group 1 (6-8 years) participants, those in group 3 (11-13 years) were significantly more likely to use specific labels and metaphors when describing how their pain felt. Group 1 participants were more likely to use synonyms or discuss intensity when describing their pain.

Injury definition. A one-way analysis of variance revealed that the 3 age groups did not differ with respect to the type of definitions they used when describing an injury. The majority of subjects defined an injury as a type of specific, identifiable damage to their body.

Understanding of pain causality. A one-way analysis of variance followed by LSD post-hoc tests revealed group 2 (9-10 years) and group 3 (11-13 years) participants to have a significantly ($p < .05$) more mature understanding of how pain is caused. Fifteen participants were able to describe the role of the brain

and/or the nerves in pain causation.

Understanding of the value of pain. A one-way analysis of variance followed by LSD post-hoc tests revealed group 2 (9-10 years) and group 3 (11-13 years) participants to describe significantly ($p < .05$) more "good things" about pain than group 1 (6-8 years) participants.

Secondary gain. A one-way analysis of variance followed by LSD post-hoc tests revealed group 3 (11-13 years) participants to describe significantly more instances where they had used pain for secondary gain than group 1 (6-8 years) or 2 (9-10 years) participants.

Use of cognitive techniques. Crosstabulation revealed that two participants in each age group reported using a cognitive technique in response to pain.

Responses to pain. Crosstabulation was used to determine the most popular responses to the various types of pain (see Appendix C for a description of the pain types). For pain types B (exertion), C (muscle stiffness), and D (momentary) the majority of participants reported continuing gymnastics. Most participants continued gymnastics with type E pain (minor acute injury), but only after they had made some response to it such as changing their technique or stretching. All participants having experienced type F pain (serious acute injury) reported they stopped what they were doing, treated the pain with something such as ice, and did not continue gymnastics. In response to type G pain (chronic), participants reported continuing gymnastics after either switching their physical activity or treating the pain with something like ice or stretching.

Rationales for responses to pain. Rationale 4, "Not serious, or nothing can

be done" was used by the majority of participants in rationalizing their responses to pain types B (exertion), C (muscle stiffness), and D (momentary). Few participants used rationale 4 for type E (minor acute injury) pain, no participants used it for type F (serious acute injury), and about 50% used it for type G pain (chronic). Rationale 10, "To achieve a conditioning effect" was used by 35% of the participants in discussing type B pain (exertion), but was rarely used with the other pain types. Rationale 15, "To reduce/prevent further pain" was used frequently with pain types D, E, F and G (momentary, minor and serious injury, chronic), and rarely with types B and C (exertion, muscle stiffness). Rationale 16, "To prevent further damage" was used very rarely for pain types B and C, but was used quite frequently for pain types D to G. The majority of gymnasts having had chronic pain stated that they believed adults (e.g., coaches, parents) could be relied on to tell them what to do about chronic pain.

Gymnasts were more likely to think of the future consequences of pain types E, F, and G (minor and serious acute injury, chronic pain) than they were to think of the importance of training or competing. No participant reported continuing gymnastics with a serious acute injury (type F) due to any of the following rationales: wanting to compete or achieve goals, pressure from others, pain is a part of sport.

Gymnasts of all ages appreciated that there were things they could do in response to pain to prevent further pain and/or damage. Younger participants more frequently used the method of direct physical treatment, such as ice or stretching, in the management of pain. Older gymnasts, on the other hand, recognized that there

were additional things they could do, such as changing their physical activity, to reduce pain and prevent injuries.

Effects of continuing gymnastics with pain. The majority of gymnasts believed that if they continued to train with type B (exertion) pain they would achieve a conditioning effect. Most gymnasts believed that nothing would happen to their bodies if they continued with pain types C (muscle stiffness) and D (momentary) and that damage could occur or intensify if they continued with types E, F, and G (minor and serious acute injuries, chronic).

Discussion

The aim of this study was to learn about young gymnasts' understanding of a number of concepts concerning sport-related pain. Of special interest was gymnasts' understanding of pain causality and the value of pain, since previous research with general populations has revealed children to have a very immature grasp of these concepts. In addition, the study was designed to find out whether young gymnasts are able to distinguish different types of pain, and if so, whether they respond differently to each type of pain.

Since no standard method of interviewing athletes about their experiences with and responses to sport-related pain existed, an interview for this purpose was designed over several stages. Questions comprising the Response to Athletic Pain Interview (RAPI) were piloted on young athletes from a variety of sports. During piloting, questions were modified and prompts added so as to obtain as complete a picture as possible of the various ways in which athletes respond to pain and the rationales they have for their responses. Other questions asked athletes to describe how their pain felt, to define an injury, to explain how pain is caused, to describe the value of pain, and to describe any instances of using pain for secondary gain. In its final form, the RAPI included a scoring system such that interviews were scored from audio tapes by a research assistant.

Other measures used in the study included the Vocabulary and Pattern Analysis subtests from the Stanford-Binet Intelligence Scale (SB score), tests of

cognitive developmental level based on Piagetian theory, and background questions to assess variables such as number of years in gymnastics and experience with pain and injury. Although age, SB score, and cognitive developmental level were expected to correlate significantly, the latter variable did not correlate with the two former ones. Further, cognitive developmental level did not discriminate performance on any of the dependent variables.

The failure of the cognitive developmental task to produce expected results appeared due to the fact that the task chosen was a poor one. The Blocks task simply did not measure the construct of cognitive development. Future research should include tests of cognitive development with proven validity and reliability. Crow (1997) has used the Cartoon Conservation Scale with children aged 5 to 13 years in developing an instrument to assess children's pain perspectives.

Validity and Reliability Issues

Research concerning understanding of pain in general populations of children commenced with researchers developing their own interview methods. Research in that area has now progressed to the point where investigators are validating their instruments and ensuring their reliability (Crow, 1997; McGrath, Speechley, Seifert & Gorodzinsky, 1997). This progression must likewise take place in the area of athletics, where questions such as those in the RAPI must be validated on athletes from different sports. Researchers would be wise to follow the example of Crow (1997) who documents the development of an inventory for assessing children's pain perspectives. Suggestions are made below for which items to retain on the RAPI's "response" and "rationale" categories for future research with gymnasts.

In this project age was used to group participants. However, a group of athletes at a particular age may be at different levels in their sport. In gymnastics, for example, athletes undergo periodic testing and on the basis of their performance are placed in a particular level of competition. The same is true for other sports, such as in the martial arts where athletes progress through the different colors of belts. Future research may compare the effect of level of competition versus age on the understanding of pain concepts.

In the present study, type of injury resulting in pain was classified according to the coding system presented in Appendix C and developed with the procedure described in the Method section. Although scales for indexing very severe injuries exist, no coding scheme for minor injuries existed. Peterson, Saldana and Heiblum (1996) recently developed the Minor Injury Severity Scale, which may be useful for classifying sport-related injuries. Future research must strive to find reliable scales with which to index types and severity of injuries in sport.

The Influence of Age

As expected, age had a great impact on a number of dependent variables. Participant performance on variables expected to be influenced by age is discussed below.

Number of different types of pain identified. Each of the three age groups differed significantly in terms of how many different types of pain they had experienced. The oldest age group described significantly more types of pain, reflecting what is probably a combination of their greater experience with sport-related pain, their greater understanding of different pain sensations, and, perhaps,

their better verbal ability. Although verbal ability should not be ignored as a factor, discussion with coaches revealed that younger gymnasts were not training at a level so as to experience pain the day after a strenuous work-out (Type C) and had far fewer injuries than older athletes. Thus, it is more likely that experience with pain and injury, which was correlated with age, accounted for the difference in the number of types of pain experienced rather than verbal ability. It would be interesting to compare children having little experience with pain and injury to gymnasts on the ability to identify different pain types. Such a comparison may determine whether age or experience with injury is more relevant in being able to distinguish pain types.

The distinction between exertion and pain. The majority of participants from each age group did not believe the sensations they experienced due to exertion to be "painful." In response to the question, "Would you call that (exertion) pain?," one six-year-old girl replied "...it hurts, but you can keep on going, because it's just... 'cuz it works your muscles." Having had experience with this type of sensation, the gymnasts felt able to determine the relatively benign nature of it, and many of them appreciated the training effect it signalled. That children can make distinctions in types of pain has also been shown in children suffering pain due to illness. Stefanatou & Bowler (1997) found children aged 5 to 13 years were able to distinguish pain due to sickle cell disease from other pain and that this ability increased with age.

Coaches may want to provide information early on regarding different types of pain and the meaning of pain due to exertion. Young athletes may benefit from

learning how exertion pain occurs and the effect of it. Such information may encourage them to consistently train to achieve a conditioning effect without overtraining. As stressed by Caine and Lindner (1990), however, it is sometimes difficult to determine the "fine line" which can exist between the physical work load producing a training effect and that producing an injury. In addition, any experienced athlete knows that both pain due to exertion and pain due to an injury can occur simultaneously, and one may mask or distort the perception of the other. For the reasons described above, it may be helpful for coaches to explain to young athletes the difference between "pain" due to exertion and pain due to an injury, and how to identify and respond to each type in a way that both maximizes progress in the sport and minimizes incidence of injury.

Rationales per response to pain. Participants aged 9 to 13 used significantly more rationales to explain their responses to pain. The older gymnasts considered more factors when responding to pain, reflecting their practice of not simply responding to pain because it hurts, but because of what it may or may not imply. For example, the older gymnasts understood that some types of pain had to be cared for in order to prevent further damage to the body. Again, this result may be influenced by verbal ability as well as children's ability to consider rationales for responding to pain. More intensive prompting may have elicited more rationales from the younger children. As discussed by Ross and Ross (1984b), the type of questioning determines the type of response obtained.

It is important for researchers to consider a number of different methods of obtaining information from children and using the one that will allow children to

provide as much information as possible. Questioning young children may be best done with imaginative and entertaining vignettes or by asking children about something concrete they can understand. For example, children could be asked "What if your teddy bear hurt her arm like you did doing gymnastics, why would she tell her coach?"

Use of pain descriptors. The 6- to 8-year-old gymnasts were unable to give clear descriptions of their pain, and specific labels and metaphors were not used with great frequency until age 11. These results confirm other findings (Harbeck and Peterson, 1992) that children between the ages of 6 and 8 are unable to provide specific labels for pain sensation. When asked what the pain felt like after she struck her head, one 6-year-old gymnast stated "Like I banged my head." When describing another type of pain, however, this same girl said "It feeled like it was stinging a little bit." Use of specific labels such as "stinging" were quite rare among the 6- to 8-year-olds.

Specific labels are important for health care professionals who often use this information from a patient in making a diagnosis. It is much more informative to the professional to know that the pain has a "stabbing" sensation than to hear that "it hurts a lot." Professionals need to be aware that children below the age of 9 are unlikely to provide specific labels that are generally used for diagnosing pain conditions.

Most gymnasts aged 11 to 13 used metaphor or specific labels to describe their pain. As an example of a metaphor, a 12-year-old boy described the pain from his "rips" (skin torn from the hands) this way: "It feels like underneath your nails -

sensitive - and it hurts to touch it and stuff. So its like fine then but as soon as you put your finger on it or something, then it like really, I can't think of a word, I don't know - I can't think of what it feels like." Common examples of specific labels were "sharp," "dull" and "stinging."

The 11- to 12-year-old participants in Harbeck and Peterson's (1992) study relied on intensity, duration and metaphor when describing their pain. Compared to that sample of general children, the gymnasts in this study had an enhanced ability to use specific labels when describing how their pain felt. It is possible that gymnasts, having had more experience with pain than general populations of children, are better at describing pain due to being asked more frequently for pain descriptors by their coaches and health care professionals.

Understanding of pain causality. Gaffney and Dunne (1987) attempted to assess children's understanding of the causality of pain by asking them to complete the sentence "A person gets pain because...." Of the 680 participants aged 5 to 14 years, only 10 gave a physiological explanation which included descriptions of pain functioning as a warning to take some action and descriptions of the mechanism of pain sensation. Trauma, such as bumping one's head, was described by 213 participants, while almost half the participants (323) described some type of transgression as the cause of pain. Transgression included things like eating too much, running too far, going outside without a coat, and being naughty. Gaffney and Dunne (1987) interpreted their results to indicate that children believed that they would be punished with pain for misbehaving (immanent justice). However, children's understanding of any concept depends not only on their cognitive

development, but on researchers' ability to develop strategies to clearly elicit their understanding (McGrath, 1995).

The manner in which Gaffney and Dunne (1987) posed their question to the children pulled for responses reflecting trauma or transgression. When asked what causes pain, most people will invariably recount an event which caused them to feel pain. It is not conventional for people to describe the mechanism of pain sensation when they are asked "how did you get hurt?" or "what caused your pain?" They will describe the event (e.g., eating too much causing a stomachache or banging into the coffee table causing a bruise) which led to pain. Likewise, the children in Gaffney and Dunne's (1987) study were answering the question in an acceptable manner by listing possible events, such as eating too much, which might result in pain. Responses indicative of transgression do not necessarily mean that the children believed in immanent justice.

Another interpretation of the results of Gaffney and Dunne (1987) is that the children understood the existence of a connection between overeating and stomachaches or watching too much TV and headaches, and, if prompted, may have been able to describe what actually caused them to feel pain. As pointed out by Wilkinson (1988) and Ross and Ross (1984b) the way in which questions are asked influences the answer given. Questions asked as a form of "testing" tend to produce the least elaboration from children (Wilkinson, 1988).

Harbeck and Peterson (1992) used a more specific type of questioning to assess children's understanding of the causality of pain. They presented vignettes to the children and asked them to think about the story and say why their body part

hurt. They found that when a general population of children aged 6 to 7 years were asked what causes the pain from a skinned knee, their responses typically reflected a re-statement of what caused the injury rather than what caused the pain. Those participants age 8 to 10 tended to provide a description of the pain rather than saying why a pain hurts while those aged 11 to 12 described things they could see or feel, such as the skin coming off. Children did not describe transgression as a reason for pain. The difference between the procedures used in Gaffney and Dunne (1987) and Harbeck and Peterson (1992) is that in the latter study children were given a specific incident to consider and then asked "why the pain hurts" as opposed to being asked to list possible reasons as to why pain occurs. The method used by Gaffney and Dunne (1987) was vague, and children responded to the question in a socially acceptable manner by listing things which could result in the experience of pain.

In the present study, the question to assess gymnasts' understanding of the causality of pain was further refined to discourage participants from describing the event which caused pain and to encourage them to think about the mechanism of pain sensation. Participants were asked to consider a gymnast who twisted her/his ankle and to describe why the gymnast felt pain. If they recounted the cause of the injury, or described a physiological event which led to the pain, they were further prompted to describe the mechanism of pain sensation ("Yes, but what's going on in her/his body that causes her/him to feel pain?"). This method resulted in 22 of the 68 participants describing the role of nerves and/or the brain when describing what causes pain. A comparison of the results of this study with those of Gaffney and

Dunne (1978) and Harbeck and Peterson (1992) highlights the importance of choosing appropriate questions when doing research based on non-standardized questions. The wording of a question can pre-determine the response it is designed to elicit.

The results of this dissertation are consistent with those of previous research (Gaffney & Dunne, 1987; Harbeck & Peterson, 1992) in that they support a developmental trend in understanding pain causality. However, the participants in this study had an understanding of pain causality that went far beyond that displayed by participants in previous research. Gaffney and Dunne (1987) found only 10 of their participants aged 8 to 14 (2%) to use a physiological explanation for pain and no participants age 5 to 7 used such an explanation. Although they did not provide information regarding the number of children using each type of response, Harbeck and Peterson (1992) found that participants aged 8 to 12 tended to provide a description of the pain event rather than using a physiological explanation of pain causality. Even college freshman were found more likely to describe factors contributing to pain rather than providing physiological explanations (Harbeck & Peterson, 1992).

The gymnasts in this study aged 6 to 8 did not use physiological explanations for pain causality, consistent with previous research. Often, like this 6-year-old girl, they said pain was caused "'cuz it hurts." The younger gymnasts were also likely to describe the cause of the injury instead of the cause of pain. For example, one 7-year-old girl said the pain in the gymnast's ankle was caused "'cuz she twisted it." Older children included physiological content in their answers. For example,

one 9-year-old boy replied, "Because the muscle - I don't know what it is - like the muscle gets stretched too far or something." A few gymnasts considered cognitive causes, such as this 12-year-old boy who said, "Its hurt and I don't know - maybe it's because they see it and they know its supposed to hurt - maybe that's why."

The present study found 15 (32%) of participants aged 9 to 13 to describe the role of the nerves and/or brain in pain causality, a percentage much higher than that found previously. Other research has revealed children learn concepts not just by growing older, but by gaining experience with them (Gelman & Baillargeon, 1983; Harris, 1993). Since gymnasts probably have more experience with pain than general populations of children, it is intuitive that their understanding of pain causality develops more rapidly. It appears that gymnasts may be more "in tune" with their bodies (Thornton, 1990) than the general samples of participants used in previous research examining children's concepts of pain (Gaffney & Dunne, 1987; Harbeck & Peterson, 1992).

It is also possible that it was the manner in which the pain causality question was asked rather than the population which produced the result. The following is an exchange with a 13-year-old female gymnast:

Interviewer: Now suppose a gymnast twisted her ankle and it hurt. Why does she feel pain?

Gymnast: Because her ankle - she's stretched it the wrong way and its not used to going that way.

Interviewer: Right - not used to it - okay - and what's going on in her body that causes her to feel the pain?

Gymnast: Her ankle is sending signals to her telling her its hurt.

Interviewer: Okay, sending signals to where?

Gymnast: Her brain.

Prompting general populations of children in a manner similar to the one

used in this study may produce a similar result. That is, asking children specifically what goes on inside the body to cause one to feel pain may elicit responses that previous researchers have taken as representing an advanced understanding of physiology, but are really concepts learned by the age of 10 (as discussed below).

Surprisingly, there was no difference in understanding of pain causality between groups 2 (9-10 years) and 3 (11-13 years). Several of the 10-year-old participants mentioned that they had recently learned about pain sensation in school that year. Thus, many of the participants in group 2 had recent knowledge of the role of the nerves and brain in the process of pain sensation while some of the older participants may have already forgotten this information.

Understanding the value of pain. Approximately one third of the participants recognized pain's value as a signal to stop activity and/or check and see what is wrong. For example, one 10-year-old boy said pain "tells you when you're hurt so you don't keep going." This result is quite different from that of Harbeck and Peterson (1992), who found 6- to 12-year-olds tended to see the value of pain from a skinned knee only in terms of secondary gain. The majority of their 6- to 10-year-olds could not think of a single value for pain, and even college students tended not to see the diagnostic value of pain (Harbeck & Peterson, 1992). Once again, it appears that experience with pain and injury helped the young athletes in the current study develop knowledge about pain that general populations of children may lack.

More recent research (McGrath et al., 1997) has revealed 68% of a sample of 5- to 16-year-olds recognized pain as a warning signal and that this recognition increased with age. Unfortunately, the authors did not reveal the questions used to

elicit this knowledge or what responses constituted recognition of pain as a warning signal.

A large number of participants from all groups said that "pain" was a good thing when it let them know that they had been working hard. In these cases pain was described as feeling exhausted or as having sore muscles. For example, an 11-year-old girl said "...the burning in your muscles. That's good because the muscle regenerates itself and gets stronger." The type of pain being discussed in this case (due to exertion) may be more relevant to pain's utility than the types of pain used in previous research by Harbeck and Peterson (1992).

A few of the athletes made reference to the "no pain, no gain" axiom when describing this value of pain. Beyond working hard, many of the older athletes saw pain as valuable when it indicated an improvement in physical condition; none of the participants aged 6 to 8 years mentioned this value of pain. It is possible that some young athletes misinterpret the axiom "no pain, no gain" to mean they should keep training even with pain due to an injury. Since this axiom is used so frequently and so widely (it was seen on a poster in one of the gyms from this study), coaches should take care to clarify to their athletes its intent.

Secondary gain. Ross and Ross (1984a) found 35% of their sample of children aged 5 to 12 years reported using pain for secondary gain. In the present study 41% of the gymnasts reported pretending they had pain or exaggerating their amount of pain to avoid some activity or to gain attention or favours (this included seeking secondary gain at home/school). Snyder (1990) suggested athletes may use pain to account for a poor athletic performance, for example, saying they fell from

the beam because of a painful ankle injury rather than due to error. In the present study none of the gymnasts said they had used pain to account for a poor performance; however, although the gymnasts were asked about using pain for secondary gain in the gym, they were not prompted to discuss situations where they may have used pain for the specific purpose of accounting for a poor performance.

Six (20%) gymnasts from group 3 (11-13 years) said they had pretended to be in a lot of pain to avoid doing something they were scared of in the gym. This finding highlights the feats these children are performing on a daily level. Certainly coaches are available to provide assistance during these complex moves, but young gymnasts continually take risks and ask themselves to do things they sometimes feel are not in their best interests.

Injury definition. The three age groups did not significantly differ in how they defined an injury. Among the 68 participants, 35 definitions were categorized as a specific type of identifiable damage and 15 were categorized as a non-specific hurt, pain, fatigue, or sensation. Only eight participants described an injury in terms of how it limited their activity. With appropriate prompts, it is possible that more participants would have used this latter response mode. For example, asking participants how an injury affects them may have elicited this type of information.

Prediction of understanding of pain causality. The best predictor of understanding of pain causality was age. The variables of training hours per week, injury experience, and number of different types of pain identified added an insignificant amount to the regression solution. Given the high correlations found between age and these three variables, the result was not surprising. That is, as age

increased, so did the number of hours spent training, number of injuries, and ability to identify different pain types. It would be interesting to compare understanding of pain causality between two groups of young athletes who trained an equivalent number of hours but who differed in their experience with injury. If injury experience predicts understanding of pain causality, then those with more injuries should have a more cognitively mature concept of pain causality.

Cognitive techniques. Two participants in each age group responded to pain by using some type of cognitive technique. This result was unexpected. Not only were more participants expected to report using cognitive techniques, older participants were expected to use them more frequently. The use of cognitive strategies by children undergoing painful medical treatments has been well documented (Branson & Craig, 1988; Brown et al., 1986; Siegel & Smith, 1989) and results have revealed older children to use these strategies more frequently than younger ones. Younger children tend to rely on behavioral strategies such as holding a parent's hand.

It is possible that participants in the current study did not think to describe their use of cognitive techniques as they were asked what they did when they had pain, not what they thought. Since it may not occur to participants to describe their cognitions in response to pain, future research designed to glean such information will require a question aimed specifically at cognitive techniques. For example, athletes could simply be asked what they thought during an experience with pain.

Sex Differences

On average, the girls trained 5 hours per week more than the boys. Boys do

not mature as quickly as girls in the sport of gymnastics, therefore they are able to gradually enter the sport. By the age of ten girls often know whether they have a future in competitive gymnastics. When studying gymnastics, researchers might best study the sexes independently when investigating any variable that may be affected by training time. In addition, using training time as an independent variable should be avoided if other variables are expected to be affected by age and/or cognitive skills. That is, comparing boys and girls both training 10 hours per week would result in the girls being younger than the boys. The above is an instance of the so-called matching problem (Miller, 1998), that is common in developmental research.

Girls rated gymnastics as significantly more important than boys. This may be due to the fact that girls were training more hours per week and thus had less time to devote to other activities that may have been important to the boys. Another consideration is that girls mature in the sport so much earlier than boys, so for the girls gymnastics was "serious business." The girls really have little time for fun during training as they must quickly make improvements in their skill and conditioning levels. Indeed, the atmosphere at the boys' gym was much less intense than at the girls' gym. The boys appeared to have more time to "horse around" than the girls.

There were no sex differences in variables such as number of different pain types identified, use of pain descriptors, understanding of pain causality or value of pain, injury definition, and use of pain for secondary gain. Since recent research with general populations of children has revealed boys to be greater risk takers and report more injuries than girls (Jelalian, Spirito, Rasile, Vinnick, Rohrbeck, &

Arrigan, 1997; Morrongiello, 1997;), it would be interesting to compare male and female gymnasts on these two variables.

Degree of Danger Posed by Gymnastics

When asked to describe the event causing their "most pain ever" a gymnastics-related event was described by 52% of the participants while 42% of them described a non-sport related incident (e.g., falling out of a tree or off a bicycle). Only 4 participants mentioned another sport as the context for their "most pain ever." However, many of the participants had gymnastics as their sole sport or were participating only casually in other sports.

It is difficult to know how to interpret the above result. Although gymnastics was only slightly more dangerous than everyday activities such as riding a bicycle or climbing a tree, the comparison was between gymnastics and all other activities combined. While it is true that some of the gymnasts spent a great deal of their spare time in the gym, many of them had time for other activities. In addition, this result does not include other injuries that are less painful, such as chronic over-use injuries. It would be informative to compare gymnasts to athletes from other sports on what type of event has resulted in the most pain.

In addition to the question about the event producing the "most pain ever," there were some other findings related to the dangerous aspects of gymnastics. One example of the dangerousness of gymnastics is the finding that six gymnasts reported pretending to be in pain in order to avoid doing something they were afraid of in the gym. Another finding was that 50% of the gymnasts aged 11-13 years reported having experience with chronic pain. This latter illustrates the need for increased

medical attention as chronic pain problems in such a young population may lead to disabilities in everyday life as the gymnasts mature.

Responses to the Different Pain Types

One 8-year-old girl, when asked what she would do if she broke her arm, replied, "I'd come back with a cast, and then my coach will know that I shouldn't have been working as hard. 'Cuz sometimes we don't work, like, good enough, and sometimes we go a little further than the line." This statement is remarkable as it provides evidence for the "line" which seems to exist between optimal-training and over-training and the difficulty in knowing where to find that line (Caine & Lindner, 1990).

The majority of participants reported continuing gymnastics when experiencing the following types of pain: exertion (type B); muscle stiffness the day after training (type C), and momentary pain (type D). See Appendix C for a description of the pain types. Most participants also continued gymnastics with pain due to a minor injury (type E), but only after they had made some response to it such as changing their technique or stretching. All participants having experienced pain due to a more serious acute injury (type F) reported they stopped what they were doing, treated the pain (e.g., ice), and terminated that session. These results indicate participants' belief in their ability to differentiate pain that should not be "worked through" versus pain that can be ignored.

In responding to chronic pain (type G), most participants reported continuing gymnastics after either switching their physical activity or treating the pain with something like ice or stretching. However, they acknowledged that these responses

really did not eliminate the pain and that they had learned to simply continue despite the pain. Although some of the participants reported that they currently ignored their chronic pain, they did tell their coach and/or seek professional advice at the original onset of pain.

Tolerance for Sport-Related Pain

The gymnasts' ability to tolerate the above types of pain does not indicate that they possessed a generally high level of pain tolerance. The tolerance is situation-specific (Scott & Gijsbers, 1981) resulting from the reinforcement parameters specific to the training environment. Pain experience reflects not only biological and psychological parameters, but also depends on the social context under which it occurs (McGrath & McAlpine, 1993). According to the radical behavioral model of pain proposed by Jaremko et al. (1981) this tolerance for sport-related pain does not necessarily generalize to other pain situations. Since pain is a subjective experience (Merskey, 1986), it only occurs when the individual labels the sensation as pain. Further, pain is only experienced as aversive if the individual perceives it to be aversive. Thus, according to the radical behavioral model, while a child may label the sensation from a needle "painful" and try to avoid that stimulus, the same child may label certain types of gymnastics sensations as "not pain" and find them non-aversive.

Rationales for Responding to Pain

The majority of participants based their response to pain due to exertion, muscle stiffness, or momentary pain (types B, C, and D) on the rationale that the pain was "Not serious, or nothing can be done." Few participants used this same

rationale for pain due to a minor acute injury, no participants used it to rationalize a response to a serious acute injury, and about 50% used it to explain their response to chronic pain. Thus, the gymnasts felt able to determine whether pain was serious enough to react to. There is, however, a difference between thinking a pain is "not serious" versus a pain for which "nothing can be done." For example, pain from chronic injuries is often indicative of something being seriously wrong, but athletes often perceive there is nothing to be done to relieve this pain. An example of this dilemma comes from a 12-year-old boy who has just described his sore wrists and ankles:

Interviewer: Okay. What do you do for that kind of pain?

Gymnast: Just leave it cause usually it's always there. There might be one training practice where you don't feel it but every other time you do.

Interviewer: Okay, so it comes and goes but most of the time it's there.

Gymnast: Yeah.

Rationale 10, "To achieve a conditioning effect" was used by 35% of the participants in discussing pain due to exertion, but was rarely used with the other pain types. The gymnasts appeared to understand that only a certain type of pain indicated the achievement of improved conditioning. This is the type of pain relevant to the axiom "no pain, no gain." Rationale 15, "To reduce/prevent further pain" and rationale 16 "To prevent further damage" were used frequently with momentary pain, minor acute injury, serious acute injury, and chronic injury (types D, E, F and G) and rarely with exertion or muscle stiffness (types B and C). The athletes appeared to appreciate that some types of pain may worsen or lead to further damage if ignored. For acute injuries (types E and F), participants of all ages tended to respond to the pain in order to prevent further pain or further

damage. Not only did the gymnasts respond differently to different pain types as described above, they used rationales demonstrating their understanding of the need for different responses.

Chronic pain appeared to produce the most ambiguous results in terms of responding to pain. Roughly half the participants having experience with chronic pain responded to it so as to prevent further pain or damage and roughly half the participants believed that there was really nothing that could be done to address chronic pain (rationale 4). As described above, participants depended on advice from adults when deciding what to do about chronic pain. It may be important to teach parents and coaches of young athletes how to respond to chronic pain and injury. Since adults are often relied upon to make decisions for the child, coaches and parents should have as much information as possible regarding the possible consequences of training/competing with such injuries. Since many children will want to continue training with chronic pain, it is important that coaches know what training techniques will and will not exacerbate the condition, when and how to provide treatment such as ice and heat and how much rest is required between training sessions. Health care professionals are most likely able to provide this information and as much input as possible from these professionals should be sought.

Use of the RAPI in Future Research

For the most part, the wording of the RAPI questions should remain unchanged. Participants appeared to have no trouble understanding the questions, nor did they appear threatened by any of them. Question 8, which asks about use of

pain for secondary gain, might be changed to "Have you *pretended* to have pain..."

This wording is clearer and easier to understand.

The number of response and rationale categories proved to be larger than necessary. Some of the categories were rarely used while others were overlapping.

Recommended response categories. In this study, athletes' responses to pain were categorized according to 13 separate actions (see Appendix C). The following 6 response categories are suggested for use in future research: a) Paid no attention and continued sport; b) Switched activity or decreased intensity of workload; c) Physical examination or treatment by self or coach; d) Professional attention; e) Quit meet/practice; f) other. This number of responses will be much more manageable and amenable to looking at age differences.

Recommended rationale categories. Of the 21 original rationale categories, the following 8 are suggested for use in future studies: a) Reaction to painful sensation; b) Not serious; c) Nothing can be done; d) Advice from an adult (coach, health care professional, parent); e) Desire to compete or achieve goals; f) To achieve a conditioning effect; g) To reduce/prevent further pain/damage or save self for the future; h) other. These rationales are suggested as they reflect points relevant to athletes' understanding of the potential impact of training with pain. Although many athletes stated they used ice or some other form of treatment in order to "Make a specific physical change (e.g., reduce swelling)," when further prompted as to why they would do this they often described preventing more pain or further damage. Therefore, the rationale of "making a physical change" is really more of a response than a rationale.

Training Despite Pain

Many athletes are motivated to continue training despite having pain conditions (Danielson et al., 1978; Guyot, 1991; Hall & Davies, 1991; Scott & Gijssbers, 1981; Spink, 1988; Stamford, 1987). The present study provides evidence that young athletes are highly dependent on adult advice and guidance when deciding whether to train with chronic pain. Adults have the power to restrict training, either by modifying routines or by prohibiting certain activities. The results here indicate that adults must be very cautious in deciding what young athletes should do about chronic pain as these children will abide by the adults' decision. It cannot be expected that young children decide on their own to continue training with chronic pain.

As described above, only two athletes, both from the oldest age group, mentioned wanting to protect their bodies for the future as a rationale for their response to pain. Young athletes do not necessarily understand that their future functioning depends on how they treat their bodies today, thus making adult involvement in decisions regarding chronic pain conditions all the more important.

The results of this study also suggest that some children need guidance from adults in order to work through pain that is indicative of achieving a positive training effect. When asked how she felt the day following an intense workout, one girl, age 10, said, "Stiff - which to the coaches is a good sign because then we're working hard." This statement begs the question: Does the athlete think this pain is a good sign? Children will need help learning to appreciate and seek out sensations indicative of achieving a training effect and distinguishing those sensations from pain

indicating an injury.

Pressure to Train/Compete

One concern of adults working with young athletes is that children may put winning or meeting training goals ahead of caring for injuries. They fear that children are not able to make sensible choices about stopping sport when they are injured. In this study, however, not a single gymnast stated that she or he continued in sport with a serious acute injury (type F) because of wanting to compete, achieve goals, being pressured by others or because pain is simply a part of the sport. Further, when the other types of pain were examined, in only three cases did an athlete mention feeling pressured by others to continue gymnastics with pain. In this sample, athletes' motivation for responding to pain appeared to be internal rather than external.

Amongst some gymnasts there may exist "rules" regarding what qualities are necessary to be a gymnast. For example, one 8-year-old girl replied that she would try to "tough it out" in response to pain. When asked why she would do that, she replied, "Because if you burst out and cry you're not being tough at all, and if you're not tough, why should you be in gym? Because gym's about being tough, strong, and things like that." Coaches and parents need to be on guard for the development of dangerous "rules" such that athletes do not take so much pride in blocking out pain as to put themselves at risk for serious harm.

Preventing Further Pain or Physical Damage

Gymnasts of all ages appreciated that there were things they could do in response to pain to prevent further pain and/or damage to their bodies. Younger

participants more frequently used the method of direct physical treatment, such as ice or stretching, in the management of pain. Older gymnasts, on the other hand, recognized that there were additional things they could do, such as changing their training techniques, to reduce pain and prevent injuries. Since one of the factors leading to increased incidence of injury in young athletes is the use of repetitive training techniques that may lead to overuse or repetitive strain injuries (Micheli, 1986), it may be helpful to teach young athletes how to avoid such injuries early on. For example, children should learn to switch activities from an emphasis on upper body to lower body at regular intervals and to avoid using one type of body movement in a repetitious manner over a lengthy time period.

Participants did provide some evidence that their coaches were very much aware of the need to prevent injuries through changing training techniques. One 13-year-old boy described pain in his wrists when training on the pommel horse. The following exchange illustrates the coach's role in injury prevention:

Interviewer: What happens to your wrists if you keep doing pommel horse with that kind of pain?

Gymnast: Well, some of the older guys, they have, like, their wrists are so bad that they wear wrist wraps.

Interviewer: So you don't have to do that yet?

Gymnast: No, and (coach's name) is trying to make it so we don't have to, ever.

Expected Effects of Continuing Gymnastics with Pain

For each of the 6 pain types, participants were asked what might happen to their bodies if they continued training with that type of pain. During pilot interviews it was evident that the young athletes were unable to consider pain types with which they had not had experience. Therefore, participants were asked to

respond to this question only if they reported having experience with the pain type. The majority of participants believed that a conditioning effect would be achieved if they continued with pain due to exertion (type B). Thus, most of the gymnasts appeared to appreciate the necessity of doing their conditioning routines. This appreciation may be accelerated in younger athletes by teaching them what this type of "pain" signals and why it is desirable.

For pain occurring the day following a workout (type C), there were an equal number of responses that nothing would happen to their bodies and that pain or damage might intensify if they continued with this type of pain. Few participants described this type of pain and it would be interesting to obtain more data regarding the incidence of this type of pain and how athletes respond to it. Certainly this experience of pain is unpleasant, and the pain may intensify if the sore muscle is re-exerted, but the preliminary data obtained here suggest that young athletes believe further training is unlikely to cause more damage.

Momentary pain due to things like bumps and small bruises (type D) was commonly experienced and the majority of participants believed nothing would happen to their bodies if they continued with this type of pain. Often participants described this pain as lasting such a brief duration that they hardly noticed it. It would be interesting to observe gymnasts and general populations of children in a playground setting and compare their responses to minor bumps and bruises caused while playing (Fearon, McGrath, & Achat, 1996). It may be that this type of pain is ignored in the gym, but is paid more attention to in other contexts. There is very little secondary gain to be achieved in the gym, while the demand characteristics of

a more social setting may elicit very different responses.

Pain due to a minor acute injury (type E) was also commonly experienced by the athletes and the majority of them believed training with it could cause the pain or injury to intensify. This belief was also expressed by the majority of participants having had experience with pain due to a serious acute injury (type F). Although these results suggest that the majority of young gymnasts were aware of the consequences of continuing their sport with an injury, this does not necessarily mean they take this factor into account when training/competing. During the interview athletes were not in the process of making a decision regarding training with pain, but were detached from such an experience and therefore able to think more logically. It may be that athletes do not consider this factor when in the context of training for an upcoming event or when in the heat of competition; data gathered at the time of injury might be more illuminating.

The majority of participants having had chronic pain (type G) believed training with such pain would worsen the pain or damage. Several participants stated that although the pain might increase, they were aware from experience they would not be making their condition worse. As already discussed, decisions regarding chronic pain conditions require a great deal of input from coaches, parents and health care professionals. It is difficult to know whether damage is being exacerbated when training with chronic pain, and a young athlete should never be asked to make this decision without consulting health care providers.

Understanding Pain Concepts and Stage Theory

Meadows (1993) describes psychology's debate over whether cognition is

general (a few processes dominating cognitive behavior in all disciplines and domains) or domain specific (each subject area having its own specialized way of thinking). If cognition is general, then knowledge of all subject areas should develop at roughly the same rate. If cognition is domain specific, then knowledge only develops if one is exposed to the subject area. Meadows (1993) argues that cognition must be both general and domain specific, and the results of the present study support this view. The children in this study displayed an understanding of pain concepts that went beyond that of children in previous studies (Gaffney & Dunne, 1987, 1988; Harbeck & Peterson, 1992).

That cognition must be both general and domain specific is intuitive if one considers the differences between subject areas. For example, a carpenter will not necessarily have high plumbing skills unless experience is also gained in the domain of plumbing. However, in order to gain carpentry skills, an adequate level of general cognition must exist in order that the specialized skills can be accommodated. Every person becomes an "expert" in a field, gaining the unique skills and knowledge required to perform a specific role. Many gymnasts in this study, although very young, were already expert at understanding various pain concepts. Their expertise was gained through experience in the specific domain. Many adults will never become as "expert" as the gymnasts as they will not be exposed to the domain specific experiences required to form an expert understanding of sport-related pain.

Karmiloff-Smith (1992) concurs with Meadows (1993) in saying that the battle between nativists (built in domain-specific knowledge) and constructivists

(minimal innate knowledge and mostly domain-general learning) is unnecessary. Both authors believe any theory of human cognition must encompass both theories. For example, Piaget's constructivist view does not account for language development as the sensorimotor stage cannot explain language acquisition; some innate component must exist (Karmiloff-Smith, 1992). Karmiloff-Smith (1992) describes some of the domain-specific predispositions found in other species and uses that evidence to reason that humans are likely to have similar or more complex predispositions. Piaget's theory is not incorrect, but according to Karmiloff-Smith (1992), each domain requires a "head-start" from some innate knowledge. Karmiloff-Smith has developed a model she calls "representational-redescription" which accounts for the way in which children's representations become more flexible and allows them to access knowledge and build theories. Throughout development representational-redescription recurs within each domain and will occur in adulthood for some types of new learning.

Karmiloff-Smith (1992) also discusses the difference between a "developmental perspective on cognition" and a "cognitive perspective on development." The present study had a developmental perspective on young gymnasts' cognitions regarding pain. It may also be informative to study this development from a cognitive perspective, that is, to discover how gymnasts acquire this knowledge of pain.

Although previous research (Gaffney & Dunne, 1987, 1988; Harbeck & Peterson, 1992) has studied children's understanding of pain based on a Piaget's 'stage' approach, evidence from this study that gymnasts are 'experts' in this field

highlights the need for another approach. Indeed, Broughton (1983) has argued that revisionists after Piaget have only modified the original theory rather than coming up with a new one. This procedure has stalled finding new theories of cognitive development. The stage approach does not explain how children progress through the stages (Gelman & Baillargeon, 1983). A 'functionalist' approach appears to more clearly describe how children come to understand pain concepts. In the functionalist approach (Brown & DeLoache, 1978) children are less experienced than adults in all areas of functioning until gaining experience in particular domains. Through a series of 'novice-expert shifts,' children develop an understanding for various concepts. Without experience, development will not occur. The functionalist approach emphasizes experience over stage progression. Piaget did note the difference in children's understanding of related problems, but did not explain it. It appears that both a stage (general) approach and a functionalist (domain) approach are necessary to understand the acquisition of particular concepts. Material presented to an individual can only be comprehended and learned if the prerequisite cognitive structures exist for understanding the material. For example, 5-year-olds will not appreciate the necessity of injury prevention based on the rationale of protecting themselves for future functioning when they can barely look past tomorrow. In order to understand the long term consequences of injury and pain, children have to appreciate that they will be alive for many years and lose their sense of immortality.

Clearly what is needed now is a study wherein children having experience with sport-related pain are compared to children having no such experience on their

understanding of pain concepts. It would also be interesting to compare those having experience with sport-related pain to those having experience with pain due to medical conditions. As yet, there have been no studies examining developmental differences in the understanding of pain between children having experience with medical pain and those without such experience. Research examining the effect of experience with illness on the understanding of illness has produced mixed results; in some cases the experienced children have a better understanding of illness concepts and in other cases their understanding lags behind non-experienced children (see Harbeck-Weber & Peterson, 1993 for a review). The discrepant findings may be explained by the influence of the following variables which may have varied across studies: type of illness, severity of illness, stress, anxiety, locus of control, and education regarding illness (Harbeck-Weber & Peterson, 1993).

Conclusions

Previous research with general populations has demonstrated that although there are age-related trends, children have a naive understanding of pain causation and do not understand the value of pain. This lack of understanding could prove dangerous to children who participate in sport while experiencing pain. For example, children have been shown to be unable to identify physiological causes of pain. In this dissertation, 32% of the gymnasts aged 9 to 13 were able to describe the role of the brain and/or nerves in pain causation. Further, the gymnasts were able to identify the value of pain; especially as a signal of hard work and as a warning to stop what they were doing. These results support a functionalist approach to cognitive development as the gymnasts appeared to function as "experts" in the domain of understanding pain concepts, presumably based on their experience with pain.

The gymnasts demonstrated an ability to respond differently to different types of pain. These young athletes demonstrated an awareness of the need to stop their sport in some cases and to continue gymnastics with certain types of pain. When continuing despite pain, participants usually justified their decisions by saying that the pain was not harmful to them. When describing why they discontinued gymnastics because of pain, participants often stated that the pain or injury may worsen. Few participants stated a concern for their future functioning. No participant described pressure from coaches, parents or peers to continue gymnastics

while experiencing pain.

In this study pain of a chronic nature was often responded to by appealing to an adult; it was difficult for gymnasts to decide how to handle such a condition on their own. This result suggests children with chronic pain should be treated by a health care professional and not be left to make decisions on their own about training with chronic pain. Since the athletes in this study relied on adults to help them with chronic pain, coaches and parents need to be aware of how to avoid and how to treat chronic pain conditions.

Very few gymnasts talked about wanting to preserve their physical functioning for the future and the youngest gymnasts did not appear to understand the benefits of "pain" due to conditioning/strengthening exercises. It seems clear, therefore, that athletes would benefit from some instruction concerning different types of pain, what each signals, and how to respond to each so as to minimize the potential for developing serious injuries or disabilities.

Future research should further investigate the role of cognitive developmental level and intelligence in athlete's understanding of sport-related pain. It will be especially important to discover whether there are athletes who focus solely on winning and achievement at the expense of injuries and whether this behavior is related to intelligence and cognitive development. Future research might also focus on comparing children having experience with sport-related pain to other populations of children. For example, comparing athletes to children with no sport experience or to children having experience with pain due to medical conditions. Future research should attempt to determine the relative effects of intelligence versus

experience with pain on understanding of pain causality.

The Response to Athletic Pain Interview (RAPI) designed for this study included questions to discover how young gymnasts respond to various types of pain and the rationales they use to justify their responses. Upon analysis of the results of the RAPI, it became evident that the response categories used in this study could be collapsed in order to make the RAPI more amenable to future research. The following categories are recommended for categorizing responses to pain: (a) Paid no attention and continued sport; (b) Switched activity or decreased intensity of workload; (c) Physical examination or treatment by self or coach; (d) Professional attention; (e) Quit meet/practice; (f) other. The following categories are recommended for categorizing rationales: (a) Reaction to painful sensation; (b) Not serious; (c) Nothing can be done; (d) Advice from an adult (coach, health care professional, parent); (e) Desire to compete or achieve goals; (f) To achieve a conditioning effect; (g) To reduce/prevent further pain/damage or to save self for the future; (h) other. Future research might focus on using these categories with another sample of gymnasts as well as athletes from other sports.

Athletes' understanding of pain concepts had not been investigated prior to this study. This project was a first step in discovering the relationship between a number of variables including cognitive development, the understanding of pain concepts, and experience with injury. The results of this dissertation open many avenues along which further research may proceed and along which practical interventions for injury prevention may already be made. These opportunities are further discussed below.

Limitations

There are a few limitations to the results of this study. First, the data reflect participants' self-report of what they say they do, or perhaps think they should do, when they experience pain during participation in sport. Actual behaviors and reports from coaches were not assessed. Thus, the self-reports may have been subject to faulty or inaccurate recall, or to social desirability. However, the method is not thought to have compromised the determination of athletes' ability to discriminate types of pain or their understanding of pain causality. The method should only have affected athletes reported responses to pain. Future researchers may want to observe and gather data during training in order to determine what children actually do when faced with pain.

Second, the study relied on verbal report from children, and, therefore, the youngest children's responses may reflect their limited ability to express themselves rather than their true understanding or behavior. On the other hand, verbal report is important for coaches, parents, and health care professionals when trying to help a child in pain. Therefore, the results of this study accurately reflect what adults can expect from young gymnasts in terms of the children's understanding of their own pain conditions.

Third, only gymnastics was sampled and the results are not necessarily generalizable to other sports. In fact, if any results are generalizable they will only relate to sports requiring a high number of hours of training time, since training

time was strongly correlated with ability to differentiate types of pain experiences as well as performance on many other variables.

Fourth, there are some gender differences within the sport of gymnastics. Females have different events than the males. For example, the beam and uneven bars are female events while the pommel horse and parallel bars are male events. This difference is analogous to the sport of figure skating, where there are differences between ice dancing and solo skating. Another gender difference was that at any given age level, girls were training significantly more hours than boys. As described earlier, increased training time was correlated with a number of variables including injury experience, understanding pain causality, and ability to differentiate types of pain. Since girls mature much more quickly than boys in the sport of gymnastics, it may be important for future research to focus solely on males or females when the researchers are concerned with the influence of training time. In the present study, for example, 12-year-old females were training approximately 25 hours per week while same age males were training approximately 10 hours per week.

Finally, age was used to group participants rather than level of competition. Gymnasts, as with other sports, requires athletes to progress through different levels and meet certain requirement before moving onto the next level. It is possible to have different aged children at the same competitive level. Future research may examine the effect of level of competition as compared to age on children's understanding of pain concepts.

Implications

This study is a first step in assessing young athletes' understanding of sport-related pain. As described above, there are several directions open to future research in this area. The results of this study also have implications in areas which may contribute to prevention of injury in sport. Although the recommendations here are meant to benefit children, they must be implemented by adults.

Instruction for Adults

It is important for parents, coaches, and health care professionals to understand what young athletes know about pain and how children make decisions regarding their ability to play through pain. Athletes who make poor decisions in this regard are at high risk for developing severe, and perhaps permanent, injuries. Adults, therefore, need to be prepared to intervene and make the decision to play or not for the athlete. Results revealed approximately half of the gymnasts in this study believed that they should tell an adult (coach or parent) about their pain because an adult could offer help.

Adult intervention may be most necessary where pain of a chronic nature is concerned. Of the 17 gymnasts in this dissertation having experience with chronic pain, 9 of them sought the advice of an adult while 12 reported treating the condition on their own. Further, when rationalizing their decision to tell their coach about this type of pain, the gymnasts often said they were explaining their failure to perform a certain exercise rather than to get help. In most cases, these gymnasts

had already received professional treatment for the chronic pain condition and were attempting to manage it on their own.

Children with chronic pain should always be treated by a health care professional and should never be allowed to make decisions on their own about training with chronic pain. Coaches need to be aware of what training practices may exacerbate chronic pain conditions (for example, repetitive training techniques), and how to modify training when an athlete has a chronic injury. Parents need to be aware of how to treat chronic pain at home; for example, how and when to apply ice and heat.

Parents, coaches, and health care professionals can have a tremendous effect on how pain is experienced by young athletes (McGrath & McAlpine, 1993). Through instruction, modelling, and reinforcement, young athletes learn how to respond to pain. Modelling by top-ranked professional athletes is an especially important source of learning for young athletes (Ross & Ross, 1988b), and parents and coaches should be available to interpret the professional's behaviors for the youngster. For example, children may not appreciate that the professional who competes despite pain does so on the advice of well-qualified medical personnel and is no longer in a vulnerable stage of physical development. As described in the introduction, children are more susceptible to the effects of sport injuries than are adults due to their immature physiological development (Anderson, 1991; Apple, 1985; Committee on Sports Medicine, 1983) and their sense of immortality that prevents them from making long-term decisions (Thornton, 1990).

Clinics for Coaches

Coaching clinics may need to devote time to managing pain in young athletes. Results of this study revealed significant age differences in the number of different types of pain identified. Gymnasts aged 6 to 8 years identified 1.9 types, those aged 9 to 10 identified 3.1 types, while those aged 11 to 13 years identified 3.9 types. Coaches may benefit from an awareness that very young athletes do not necessarily discern between pain types the way older athletes do. Thus, coaches can learn to guide children when certain types of pain are experienced. For example, coaches can teach children what is happening in their bodies when they are doing their conditioning exercises and reassure them that the sensations they feel are not harmful.

Each sport in Canada has a National Coaching Certification Program. The training manuals for coaching certification include some instruction on acute pain management. However, the results of this dissertation revealed that chronic pain is a problem for a significant number of gymnasts aged 11-13 years. As such, the officials responsible for developing the coaching programs may want to consider including a section on the prevention and management of chronic injuries.

Instruction for Young Athletes

Children may benefit from instruction regarding the antecedents and consequences of pain, and how to manage pain more effectively. Based on their work in the domains of general illness and AIDS, Bibace and Walsh (1990) conclude that teaching prevention or other concepts will be ineffective unless the student is of an appropriate level of cognitive maturity in these domains. The youngest gymnasts

in this study (aged 6 to 8 years) were more likely to describe the sensations of exertion as painful and were less likely to understand the conditioning effect of such sensations. Gymnasts aged 8 and younger would benefit from learning about the positive consequences of doing conditioning work as well as the necessity of telling their coach when they have any other type of pain. Gymnasts aged 8 and younger are unlikely to benefit from information regarding the connection between training with pain and possible further damage to their bodies. These youngsters should simply be told to report any pain experience to their coach and to a parent.

The gymnasts in this study did not provide evidence of considering their future functioning when making decisions regarding what to do about pain. Gymnasts aged 9 and older would benefit from information regarding the future consequences of continuing sport despite pain. Children need to be taught how pain they experience today may affect them tomorrow.

Instruction with athletes might take place using a series of vignettes where the athletes are asked to describe what should be done in each situation and why. Athletes could then be given information regarding the consequences of various responses and the safest way of handling each situation. Coaches should be present during instruction to ensure their approval of what is being taught to the athletes and to obtain their view of the various vignettes.

Sex Differences

The results of this study revealed two sex differences which may be important to those professionals treating gymnastics injuries. The girls not only trained an average of 5.25 hours more per week, they also viewed gymnastics as

more important to them compared to the boys. Although not investigated in the present study, it may be that girls will experience more pressure to resume training following an injury. Clinicians may want to take extra time with competitive female gymnasts explaining the potential long-term effects of continuing to train after an injury.

There were no differences between the boys and girls in terms of the pain descriptors they used. The average type of descriptor was the use of metaphor, for example, "like a wrench around my arm." With prompting, clinicians may be able to elicit more specific pain descriptors, even from very young gymnasts.

Injury Prevention

Parents and coaches will have to take active steps in preventing athletic injury. Research has shown that although parents usually use lectures to intervene after a child sustains an injury, children rarely remember the lectures (Peterson, Bartelson, Kern & Gillies, 1995). Thus, it will not be enough to tell children what types of training techniques to avoid, coaches will have to take other steps to prevent such behavior.

Assessing young athletes' understanding of pain and injury responds to the recommendation of the Society of Pediatric Psychology Task Force (Finney et al., 1993) that psychologists become more involved in the control of injuries to children. Further, this study responds to the recommendations made in the 1993 report on Injuries in Saskatchewan by addressing primary injury prevention in the social environment. Health costs due to injury are substantial in Saskatchewan and in all of Canada, with sport-related injury accounting for a great amount of that cost.

Preventing injuries at the primary stage is the most cost-effective form of injury prevention. Teaching young athletes the implications of pain may also serve to meet one goal of the World Health Organization, which is to reduce the severity and extent of injuries due to sport.

References

- Abu-Saad, H. (1981). The assessment of pain in children. *Issues in Comprehensive Pediatric Nursing*, **5**, 327-335.
- Adler, R., Bongar, B. and Katz, E. (1982). Psychogenic abdominal pain and parental pressure in childhood athletics. *Psychosomatics*, **23**, 1185-1186.
- American Academy of Pediatrics, Committee on Sports Medicine (1983). *Sports Medicine: Health Care for Young Athletes*. Smith, N. J., (Ed.). Evanston, Illinois: American Academy of Pediatrics.
- Anderson, S. J. (1991). Overuse knee injuries in young athletes. *The Physician and Sportsmedicine*, **19**, 69-80.
- Apple, D. F. Jr. (1985). Adolescent runners. *Clinics in Sports Medicine*, **4**, 641-655.
- Backx, F. J. G., Beijer, H.J.M., Bol, E. and Erich, W.B.M. (1991). Injuries in high-risk persons and high-risk sports: A longitudinal study of 1818 school children. *The American Journal of Sports Medicine*, **19**, 124-130.
- Baker, S. P., O'Neill, B., Ginsburg, M. J. and Li, G. (1992). *The Injury Fact Book*. New York: Oxford University Press.
- Baxter, L. A. (1991). Content analysis. In Montgomery, B. M. and Duck, S. (Eds.), *Studying interpersonal interaction* (pp. 239-254). New York: Guilford Press.
- Bibace, R. and Walsh, M. E. (1979). Developmental stages in children's conceptions of illness. In Stone, G. C., Cohen, F., and Adler, N. E. (Eds.), *Health psychology - a handbook* (pp. 285-301). San Francisco: Jossey-Bass, Inc.

Bibace, R. and Walsh, M. E. (1980). Development of children's concepts of illness. *Pediatrics*, **66**, 912-917.

Bibace, R. and Walsh, M. E. (1990). Understanding AIDS developmentally: A comment on the November 1988 special issue on psychology and AIDS, *American Psychologist*, **March**, 405-407.

Bournaki, M. (1997). Correlates of pain-related responses to venipunctures in school-age children. *Nursing Research*, **46**, 147-154.

Brainerd, C. J. (1978). The stage question in cognitive-developmental theory. *The Behavioral and Brain Sciences*, **2**, 173-213.

Branson, S. M. and Craig, K. D. (1988). Children's spontaneous strategies for coping with pain: A review of the literature. *Canadian Journal of Behavioural Science*, **20**, 402-412.

Brewster, A. B. (1982). Chronically ill hospitalized children's concepts of their illness. *Pediatrics*, **69**, 355-362.

Broughton, J. M. (1983). Not beyond formal operations but beyond Piaget. In Commons, M. L., Richards, F. A. and Armon, C. (Eds.), *Beyond formal operations: Late adolescent and adult cognitive development*. New York: Praeger.

Brown, A. L. and De Loache, J. S. (1978). Skill, plans and self-regulation. In Siegler, R. S. (Ed.), *Children's thinking: What develops?* Hillsdale, NJ: Erlbaum.

Brown, J. M., O'Keeffe, J., Sanders, S. H. and Baker, B. (1986). Developmental changes in children's cognition to stressful and painful situations. *Journal of Pediatric Psychology*, **11**, 343-357.

Burbach, D. J. and Peterson, L. (1986). Children's concepts of physical illness: A review and critique of the cognitive-developmental literature. *Health Psychology*, **5**, 307-325.

Caine, D. J. and Lindner, K. (1990). Preventing injury to young athletes - Part II: Preventative measures. *Canadian Association for Health, Physical Education and Recreation*, Sept./Oct., 24-30.

Cohen, J. (1960). Coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, **20**, 37-46.

Cohen, J. and Cohen, P. (1983). *Applied multiple regression/correlation analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Cowan, P. (1978). *Piaget with feeling: Cognitive, social and emotional dimensions*. New York: Holt, Rinehart, & Winston.

Craig, K. D., Grunau, R. V. and Branson, S. M. (1988). Age-related aspects of pain: Pain in children. In Dubner, R., Gebhart, G. R. and Bond, M. R. (Eds.), *Proceedings of the Vth world congress on pain* (pp. 317-328). New York: Elsevier Science Publishers BV.

Crossman, J. and Jamieson, J. (1985). Differences in perceptions of seriousness and disrupting effects of athletic injury as viewed by athletes and their trainer. *Perceptual and Motor Skills*, **61**, 1131-1134.

Crow, C. S. (1997). Children's pain perspectives inventory (CPPI): Developmental assessment. *Pain*, **72**, 33-40.

Danielson, R. R., Salmela, J. H., Proteau, L. and Régnier, G. (1978). Pain

tolerance and performance of superior Canadian gymnasts. In Terauds, J. and Daniels, D. B. (Eds.), *Science In Gymnastics* (pp.77-88). Del Mar, California: Academic Publishers.

Dunn, L. M. (1965). *The Peabody Picture Vocabulary Test*. Circle Pines, MN: American Guidance Service.

Ekstrand, J., Gillquist, J. and Liljedahl, S. (1983). Prevention of soccer injuries. *The American Journal of Sports Medicine*, **11**, 116-120.

Eland, J. M. and Anderson, J. E. (1977). The experience of pain in children. In Jacox, A. K. (Ed.), *Pain: A sourcebook for nurses and other health professionals* (pp. 453-473). Boston: Little, Brown & Co.

Elkind, D. (1961). The development of quantitative thinking: A systematic replication of Piaget's studies. *Journal of Genetic Psychology*, **98**, 37-46.

Ellison, L. F. and Mackenzie, S. G. (1993). Sports injuries in the database of the Canadian Hospitals Injury Reporting and Prevention Program - An overview. *Chronic Diseases in Canada*, **14**, 96-104.

Finney, J. W., Christophersen, E. R., Friman, P. C., Kalnins, I. V., Maddux, J. E., Peterson, L., Roberts, M. C. and Wolraich, M. (1993). Society of Pediatric Psychology Task Force report: Pediatric psychology and injury control. *Journal of Pediatric Psychology*, **18**, 499-526.

Fearon, I., McGrath, P. J., and Achat, H. (1996). 'Booboos': The study of everyday pain among young children. *Pain*, **68**, 55-62.

Flavell, J. H. (1971). Stage-related properties of cognitive development. *Cognitive Psychology*, **2**, 421-453.

Flavell, J. H. (1981). On cognitive development. *Child Development*, **53**, 1-10.

Fordyce, W. E. (1976). *Behavioral methods for chronic pain and illness*. St. Louis: C. V. Mosby.

Fowler-Kerry, S. and Lander, J. R. (1987). Management of injection pain in children. *Pain*, **30**, 169-175.

Gaffney, A. (1988). How children describe pain: a study of words and analogies used by 5—14-year-olds. In Dubner, R., Gebhart, G. F. and Bond, M. R. (Eds.), *Proceedings of the Vth World Congress on Pain* (pp. 341-347). New York: Elsevier Science Publishers BV.

Gaffney, A. (1993). Cognitive developmental aspects of pain in school-age children. In Schechter, N. L., Berde, C. B. and Yaster, M. (Eds.), *Pain in infants, children, and adolescents* (pp. 75-85). Baltimore, Maryland: Williams & Wilkins.

Gaffney, A. and Dunne, E. A. (1986). Developmental aspects of children's definitions of pain. *Pain*, **26**, 105-117.

Gaffney, A. and Dunne, E. A. (1987). Children's understanding of causality of pain. *Pain*, **29**, 91-104.

Gauron, E. F. and Bowers, W. A. (1986). Pain control techniques in college-age athletes. *Psychological Reports*, **59**, 1163-1169.

Gelman, R. and Baillargeon, R. (1983). A review of some Piagetian concepts. In P. H. Mussen (Ed.), *Handbook of child psychology*, Fourth Ed., Vol. 3, pp. 167-230.

Gielen, A. C. (1992). Health education and injury control: Integrating approaches. *Health Education Quarterly*, **19**, 203-218.

Ginsburg, H. (1997). **Entering the child's mind**. Cambridge University Press.

Ginsburg, H. and Oppen, S. (1969). *Piaget's theory of intellectual development: An introduction*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Goldschmid, M. L. and Bentler, P. M. (1968). *Concept Assessment Kit - Conservation*. San Diego, California: Educational and Industrial Testing Service.

Guyot, G. W. (1991). Psychological and medical factors associated with pain running. *The Journal of Sports Medicine and Physical Fitness*, **31**, 452-460.

Halford, G. S. (1989). Reflections on 25 years of Piagetian cognitive developmental psychology, 1963-1988. *Human Development*, **32**, 325-357.

Haddon, W. Jr., (1980). Advances in the epidemiology of injuries as a basis for public policy. *Public Health Reports*, **95**, 411-421.

Hall, E. G. and Davies, S. (1991). Gender differences in perceived intensity and affect of pain between athletes and nonathletes. *Perceptual and Motor Skills*, **73**, 779-786.

Harbeck, C. and Peterson, L. (1992). Elephants dancing in my head: A developmental approach to children's concepts of specific pains. *Child Development*, **63**, 138-149.

Harbeck-Weber, C. and Peterson, L. (1993). Children's conceptions of illness and pain. *Annals of Child Development*, **9**, 133-161.

Harder, J. M. and Seliske, P. (1993). *Injuries in Saskatchewan*. Report of

the Health Status Research Unit, Department of Community Health and Epidemiology, College of Medicine, University of Saskatchewan, Saskatoon, SK, Canada.

Harris, A. C. (1993). *Child development*. Minneapolis: West Publishing Company.

Harrison, E.L. (1992). Sports injuries at the 1989 Jeux Canada Games. *Clinical Journal of Sports Medicine*, 2, 269-275.

Haslam, D. R. (1969). Age and the perception of pain. *Psychosomatic Medicine*, 15, 86-87.

Hughes, M. and Grieve, R. (1980). On asking children bizarre questions. *First Language*, 1, 149-160.

Inhelder, B. and Piaget, J. (1958). *The growth of logical thinking from childhood to adolescence*. A. Parsons and S. Milgram, Trans. Basic Books, Inc.

Jaremko, M. E., Silbert, L. and Mann, T. (1981). The differential ability of athletes and nonathletes to cope with two types of pain: A radical behavioral model. *The Psychological Record*, 31, 265-275.

Jelalian, E., Spirito, A., Rasile, D., Vinnick, L., Rohrbeck, C. and Arrigan, M. (1997). Risk taking, reported injury, and perception of future injury among adolescents. *Journal of Pediatric Psychology*, 22, 513-531.

Jerrett, M. D. (1985). Children and their pain experience. *Children's Health Care*, 14, 83-89.

Johnston, D. and Mannell, R. C. (1980). The effects of experimentally created team norms on pain perception. In Klavara, P. and Wipper, K. (Eds.),

Psychological and Sociological Factors in Sport (pp. 306-314). Toronto: Congress of the Canadian Society for Psychomotor Learning and Sport.

Karmiloff-Smith, A. (1992). *Beyond modularity: A developmental perspective on cognitive science*. Cambridge: MIT Press.

Kenny, J. (1987). Athletic injury care training in high school coaches. *Canadian Association for Health, Physical Education and Recreation (CAHPER) Journal*, March/April, 14-20.

Koehncke, N. (1992). Sports injuries common in Canada. *Injury Awareness & Prevention Centre News*, 5, 7-8.

Krauss, R. and Glucksberg, S. (1969). The development of communication: Competence as a function of age. *Child Development*, 40, 255-266.

Kuhn, D. (1992). Cognitive development. In Bornstein, M. C. and Lamb, M. E. (Eds.), *Developmental psychology: An advanced textbook* (3rd ed.) (pp. 211-272). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Lambert, W. E., Libman, E. and Poser, E. G. (1960). The effect of increased salience of a membership group on pain tolerance. *Journal of Personality*, 28, 350-357.

Lander, J. and Fowler-Kerry, S. (1991). Age differences in children's pain. *Perceptual and Motor Skills*, 73, 415-418.

Lavigne, J. V., Schulein, M. J. and Hahn, Y. S. (1986). Psychological aspects of painful medical conditions in children. I. Developmental aspects and assessment. *Pain*, 27, 133-146.

Lautenbacher, S. and Rollman, G. B. (1993). Sex differences in

responsiveness to painful and non-painful stimuli are dependent upon the stimulation method. *Pain*, **53**, 255-264.

LeBaron, S. and Zeltzer, L. (1984). Assessment of acute pain and anxiety in children and adolescents by self-reports, observer reports, and a behavior checklist. *Journal of Consulting and Clinical Psychology*, **52**, 729-738.

Lindner, K. and Caine, D. (1990). Injury patterns of female competitive club gymnasts. *Canadian Journal of Sport Science*, **15**, 254-261.

Lord, R. H. and Kozar, B. (1989). Pain tolerance in the presence of others: Implications for youth sports. *The Physician and Sportsmedicine*, **17**, 71-77.

Martarano, S. C. (1977). A developmental analysis on Piaget's formal operations tasks. *Developmental Psychology*, **13**, 666-672.

Martin, R. K., Yesalis, C. E., Foster, D. and Albright, J. P. (1987). Sports injuries at the 1985 Jr. Olympics. *The American Journal of Sports Medicine*, **15**, 603-608.

McGrath, P. A. (1990). *Pain in children: Nature, assessment, and treatment*. New York: Guildford Press.

McGrath, P. A., Speechley, K. N., Seifert, C. E., and Gorodzinsky, F. P. (1997). A survey of children's pain experience and knowledge - phase 1. In Jensen, T. S., Turner, J. A., and Wiesenfeld-Hallin, Z. (Eds.), *Proceedings of the 8th World Congress on Pain: Progress in Pain Research and Management*, (pp. 903-916).

McGrath, P. J. (1995). Annotation: Aspects of pain in children and adolescents. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, **36**,

717-730.

McGrath, P. J., Mathews, J. R. and Pigeon, H. (1991). Assessment of pain in children: A systematic psychosocial model. In Bond, M. R., Charlton, M. E. and Woolf, C. J. (Eds.), *Proceedings of the Vth world congress on pain* (pp. 509-526). New York: Elsevier Science Publishers BV.

McGrath, P.J. and McAlpine, L. (1993). Psychologic perspectives on pediatric pain. *The Journal of Pediatrics*, **122**, S2-S8.

McGrath, P. J. and Unruh, A. M. (1987). *Pain in children and adolescents*. New York: Elsevier Science Publishers BV.

McMaster, W. C. and Troup, J. (1993). A survey of interfering shoulder pain in United States competitive swimmers. *The American Journal of Sports Medicine*, **21**, 67-70.

Meadows, S. (1993). *The child as thinker*. New York: Routledge.

Melzack, R. (1973). *The puzzle of pain*. New York: Basic Books.

Melzack, R. and Wall, P. (1988). *The challenge of pain*. Markham, ON: Penguin Books.

Melzack, R. and Wall, P. (1965). Pain mechanisms: A new theory. *Science*, **150**, 971-979.

Merskey, H. (1986). (Ed.). Classification of chronic pain: Descriptions of chronic pain syndromes and definitions of pain terms. *Pain*, supplement 3.

Meyers, M. C., Bourgeois, A. E., Stewart, S. and LeUnes, A. (1992). Predicting pain response in athletes: Development and assessment of the Sports Inventory for Pain. *Journal of Sport & Exercise Psychology*, **14**, 249-261.

Micheli, L. J. (1984). Sports injuries in the young athlete: Questions and controversies. In Micheli, L.J. (Ed.), *Pediatric and Adolescent Sports Medicine* (pp. 1-8). Boston: Little, Brown and Company.

Micheli, L. J. (1986). Pediatric and adolescent sports injuries: Recent Trends. *Exercise and Sport Science*, **14**, 359-374.

Miller, S. A. (1998). *Developmental research methods* (2nd ed.). Toronto: Prentice-Hall.

Morgan, W. P. (1978). The mind of the marathoner. *Psychology Today*, **11**, 38-49.

Morrongiello, B. A. (1997). Children's perspectives on injury and close-call experiences: Sex differences in injury-outcome processes. *Journal of Pediatric Psychology*, **22**, 499-512.

Nash, H. L. (1987). Elite child-athletes: How much does victory cost? *The Physician and Sportsmedicine*, **15**, 129-133.

Natapoff, J. N. (1978). Children's views of health: A developmental study. *American Journal of Public Health*, **68**, 995-1000.

Papalia, D. (1972). The status of several conservation abilities across the life-span. *Human Development*, **15**, 229-243.

Perrin, E. C. and Gerrity, S. (1981). There's a demon in your belly: Children's understanding of illness. *Pediatrics*, **67**, 841-849.

Peterson, C. (1996). The preschool child witness: Errors in accounts of traumatic injury. *Canadian Journal of Behavioral Science*, **28**, 36-42.

Peterson, L., Bartelstone, J., Kern, T. and Gillies, R. (1995). Parents'

socialization of children's injury prevention: Description and some initial parameters. *Child Development*, **66**, 224-235.

Peterson, L., Harbeck, C. and Moreno, A. (1993). Measures of children's injuries: Self-reported versus maternal-reported events with temporally proximal versus delayed reporting. *Journal of Pediatric Psychology*, **18**, 133-147.

Peterson, L., Saldana, L. and Heilblum, N. (1996). Quantifying tissue damage from childhood injury: The minor injury severity scale. *Journal of Pediatric Psychology*, **21**, 251-267.

Piaget, J. (1930). *The child's conception of physical causality* (M. Gabain, Trans.). New York: Harcourt Brace.

Piaget, J. and Inhelder, B. (1969). *The psychology of the child* (H. Weaver, Trans.). New York: Basic Books, Inc.

Pless, I. B. and Arsenault, L. (1987). The role of health education in the prevention of injuries to children. *Journal of Social Issues*, **43**, 87-103.

Redpath, C. C. and Rogers, C. S. (1984). Healthy young children's concepts of hospitals, medical personnel, operations, and illness. *Journal of Pediatric Psychology*, **9**, 29-40.

Régnier, G. and Salmela, J. H. (1980). Perceptual variables and gymnastic performance: Developmental considerations. In Klavara, P. and Flowers, J. (Eds.), *Motor Learning and Biomechanical Factors in Sport* (pp. 218-238). Toronto: Congress of the Canadian Society for Psychomotor Learning and Sport.

Ross, D. M. and Ross, S. A. (1988a). Assessment of pediatric pain: An overview. *Issues in Comprehensive Pediatric Nursing*, **11**, 73-91.

Ross, D. M. and Ross, S. A. (1988b). *Childhood pain: Current issues, research, and management*. Baltimore: Urban & Schwarzenberg.

Ross, D. M. and Ross, S. A. (1985). Pain instruction with third- and fourth-grade children: A pilot study. *Journal of Pediatric Psychology*, **10**, 55-63.

Ross, D. M. and Ross, S. A. (1984a). The importance of type of question, physiological climate, and subject set in interviewing children about pain. *Pain*, **19**, 71-79.

Ross, D. M. and Ross, S. A. (1984b). Childhood pain: The school-aged child's viewpoint. *Pain*, **20**, 179-191.

Ryan, E. D. and Kovacic, C. R. (1966). Pain tolerance and athletic participation. *Perceptual and Motor Skills*, **22**, 383-390.

Sattler, J. M. (1988). *Assessment of children* (3rd ed.). San Diego: Jerome M. Sattler.

Savedra, M., Gibbons, P., Tesler, M., Ward, J. and Wegner, C. (1982). How do children describe pain? A tentative assessment. *Pain*, **14**, 95-104.

Schultz, N. V. (1971). How children perceive pain. *Nursing Outlook*, **19**, 670-673.

Scott, V. and Gijsbers, K. (1981). Pain perception in competitive swimmers. *British Medical Journal*, **283**, 91-93.

Siegel, L. J. and Smith, K. E. (1989). Children's strategies for coping with pain. *Pediatrician*, **16**, 110-118.

Seigler, R. S. (1976). Three aspects of cognitive development. *Cognitive Psychology*, **4**, 481-520.

Seigler, R. S. (1986). *Children's thinking*. Englewood Cliffs, NJ: Prentice-Hall.

Simeonsson, R. J., Buckley, L. and Monson, L. (1979). Conceptions of illness causality in hospitalized children. *Journal of Pediatric Psychology*, **4**, 77-84.

Smith, A. M., Scott, S. G., O'Fallon, W. M. and Young, M. L. (1990). Emotional responses of athletes to injury. *Mayo Clinic Proceedings*, **65**, 38-50

Smith, R. E. and Smoll, F. L. (1991). Behavioral research and intervention in youth sports. *Behavior Therapy*, **22**, 329-344.

Snyder, E. E. (1990). Emotion and sport: A case study of collegiate women gymnasts. *Sociology of Sport Journal*, **7**, 254-270.

Spink, K. S. (1988). Facilitating endurance performance: The effects of cognitive strategies and analgesic suggestions. *The Sport Psychologist*, **2**, 97-104.

Stamford, B. (1987). No pain, no gain? *The Physician and Sportsmedicine*, **15**, 244.

Statistics Canada (1991). *Accidents in Canada, general social survey analysis series, no. 3, 11-612E, pp. 68-71*.

Stefanatou, A. and Bowler, D. (1997). Depiction of pain in the self-drawings of children with sickle cell disease. *Child: Care, Health and Development*, **23**, 135-155.

Sutherland, P. (1992). *Cognitive development today: Piaget and his critics*. London, England: Paul Chapman Publishing Ltd.

Thorndike, R. L., Hagen, E. P. and Sattler, J. M. (1986). Guide for administering and scoring the fourth edition of the Stanford-Binet Intelligence Scale.

Chicago: The Riverside Publishing Company.

Thornton, J. S. (1990). Playing in pain: When should an athlete stop? *The Physician and Sportsmedicine*, **18**, 138-142.

Thornton, J. S. (1991). Springing young athletes from the parental pressure cooker. *The Physician and Sportsmedicine*, **19**, 92-99.

Turk, D. C. and Meichenbaum, D. H. (1989). A cognitive-behavioural approach to pain management. In Wall, P. and Melzack, R. D. (Eds.), *Textbook of pain*. New York: Churchill, Livingstone.

Varni, J. W., Thompson, K. L. and Hanson, V. (1987). The Varni/Thompson Pediatric Pain Questionnaire. I. Chronic musculoskeletal pain in juvenile rheumatoid arthritis. *Pain*, **28**, 27-38.

Walker, J. (1971). Pain and distraction in athletes and non-athletes. *Perceptual and Motor Skills*, **33**, 1187-1190.

Weiss, M. R., Barber, H., Sisley, B. L. and Ebbeck, V. (1991). Developing competence and confidence in novice female coaches: II. Perceptions of ability and affective experiences following a season-long coaching internship. *Journal of Sport & Exercise Psychology*, **13**, 336-363.

Wilkie, D. J., Holzemer, W. L., Tesler, M. D., Ward, J. A., Paul, S. M. and Savedra, M. C. (1990). Measuring pain quality: Validity and reliability of children's and adolescents' pain language. *Pain*, **41**, 151-159.

Wolff, B. B. (1986). Behavioral measurement of human pain. In Sternbach, R. A., (Ed.), *The psychology of pain* (2nd ed.) (pp. 121-151). New York: Raven Press.

World Health Organization (1980). *International classification of impairments, disabilities and handicaps: A manual of classification relating to the consequences of disease*. Albany, NY: WHO Publications Centre, USA.

Appendix A Summary of Pilot Participants

Phase 1

Number of participants: 22.

Age range: 5 to 17.

Sports represented: Baseball, Tae Kwon Do, Gymnastics.

Measures used: Semi-structured Response to Athletic Pain Interview (RAPI).

Phase 2

Number of participants: 12 (includes 2 world class athletes).

Age range: 5 to 28.

Sports represented: Speed skating, hockey, wrestling, rowing.

Measures used: Structured RAPI with all participants and full protocol with 3 participants.

Appendix B
Response to Athletic Pain Interview - RAPI (ages 7 and over)

- 1) I'd like you to think of a time when you felt pain during gymnastics (pause) and tell me what happened and what you did when you had it.

Prompts for pain types: Have you ever fallen and hurt yourself? Do you ever have pain that you ignore? Do you have any pain that's always there? Have you ever been to a Dr./physio for gym pain? **Prompts for responses to pain:** Did you use ice? Did you tell anyone? Did you have to miss any gym time?

- 2) How come you did ____? [Ask for each thing they did in response to pain].
- 3) What do you think happens/would happen to your (body part) if you continue to do gymnastics while you have that type of pain?
- 4) Now, that type of pain we are talking about, what did it feel like? [Prompt]: tell me one or two words that says/describes how it felt. **For type B pain only:** Would you call that feeling pain?

Okay, we just talked about a type of pain that felt like (use athlete's words) and where you did (use athlete's words) because (use their rationale). Now I'd like you to tell me about another type of pain you've had that felt different or you did something different for it.

Repeat questions 2 through 4 until athlete can identify no further types of pain. If training pain is not described say: Sometimes gymnasts feel pain in their arms or their legs when they are working really hard in practice, like when you're doing conditioning things like squat jumps or rope climb. Have you ever felt something like that when you're doing conditioning?"

- 5) Okay (name), now I'm going to ask you some different kinds of questions. Tell me in your own words what an injury is. [Prompt]: What happens inside the body when someone has an injury?
- 6) Suppose a gymnast twisted her/his ankle and it hurt. Why does she/he feel pain? [Prompt]: What's going on in her/his body that causes her/him to feel pain?
- 7) Pain can sometimes be bad, but what are some good things about pain? [Prompt]: What else is good about pain?. [Final prompt]: Does pain ever let you know that you've had a good practice? [If yes]: Describe this for me.
- 8) Have you ever said you had pain so that you didn't have to do something you didn't want to do? [If no]: Not at gymnastics or at home? [If yes]: Tell me about it. [If they mention one setting (e.g., sport) ask about other.]

Response to Athletic Pain Interview - RAPI (6 year-olds)

- 1) Okay, (name) I'd like you tell me about a time when you felt a hurt during gymnastics. Tell me what happened. What did you do for that hurt? [If not clear]: Was that in a meet or a practice?

Prompts for types of pain: Have you ever fallen and hurt yourself? Do you ever have pain that you ignore? Do you have any pain that's always there? Have you ever been to a Dr./physio for gym pain? **Prompts for responses to pain:** Did you use ice? Did you tell anyone? Did you have to not come to gym for awhile?

- 2) How come you did ____? [Ask for each response to hurt].
- 3) What do you think happens/would happen to your body if you keep doing gymnastics with that hurt?
- 4)) Now, that type of hurt we are talking about, what did it feel like? [Prompt]: tell me one word that says how it felt.

Okay, we just talked about a type of hurt that felt like (use athlete's words) and you did (use athlete's words) because (rationale). Now I'd like you to tell me about different kind of hurt you've had that felt different or you did something different for it.

Repeat questions 2 through 4 until athlete can identify no further types of pain. If training pain is not described say: Sometimes gymnasts feel pain in their arms or their legs when they are working really hard in practice, like when you're doing conditioning things like squat jumps or rope climb. Have you ever felt something like that when you're doing conditioning?"

- 5) Okay (name), now I'm going to ask you some different kinds of questions. First, I'd like you to tell me what a really, really bad hurt is. [Prompt]: What happens inside the body when someone has a really bad hurt?
- 6) Suppose a gymnast twisted her/his ankle and it hurt. Why does she/he feel pain? [Prompt]: What's going on in her/his body that makes her/him feel pain?
- 7) Sometimes a hurt is bad, but what are some good things about a hurt? [Prompt for more responses]: What's another good thing about a hurt? [Final prompt]: Does hurt ever tell you that you've had a good practice? [If yes]: How does it do that?
- 8) Have you ever said you had a hurt so that you didn't have to do something you didn't want to do? [If no]: Not at gymnastics or at home? [If yes]: Tell me about it. [If one setting is described (e.g., sport), ask about other.].

Appendix C - Scoring Key for RAPI

1. I'd like you to think of a time when you felt pain during gymnastics (pause) and tell me what happened and what you did when you had it.

1a Type of Pain - check one only

A) Has never had, or can think of no instances of, pain in sport

B) Exertion or conditioning (pain when I skate hard; lactic acid build-up; doing push-ups; stretching)

C) Muscle pain/stiffness the day after a work-out (may or may not be due to taking time off sport)

D) Momentary pain having little consequence and producing nothing more than fleeting attention (landed on bar and got bruised; small rips; little muscle pull; hanging on rings and elbows hurt)

E) Minor acute injury (noticed when doing sport) (bad cramp; big rips; sprained ankle; pinched nerve)

F) Serious acute injury (rolled over ankle and it popped; tore ligament; broken bone; severely pulled muscle)

G) Chronic overuse pain problem (sore back from a lot of scar tissue; always have sore wrists; my knee's been hurting for about 6 months)

1b Response to Pain Categories - check all that apply

1) Did nothing and continued sport (precludes any other responses: tried to do my best; passively shook it off)

2) Cognitive technique (some breathing; try to forget about it; focus on different things; actively shook it off)

3) Adjusted/switched physical activity (quit the pounding stuff and did conditioning; changed my technique)

4) Decreased intensity of workload (didn't try as hard as I could; not push myself so much)

5) Physical Tx or examination by self (stretch it; strengthen it; tried to put weight on it; iced it; took anti-inflammatories)

6) Physical Tx by coach (coach put ice on it; coach taped it)

7) Told a non-professional adult (told my dad; told coach)

8) Sought or received professional Tx (went for x-ray; trainer looked at it; went for physiotherapy; was put in a cast)

9) Took short break and returned to sport (laid down until I felt better; rest between sets)

10) Quit that meet/practice (withdrew from meet; sat out of competition; quit practice)

11) Took 2 or more days off sport (quit practice and took a week off; had to take a few days off)

12) Emotional response (cried; got mad; hit someone or something)

13) Above response(s) occurred after activity (i.e., did not stop in middle of activity to care for pain)

2. How come you did ____? [Ask for each thing they did in response to pain].

Rationale for Response - check all that apply. E.g., "it was just a practice, I wanted to save myself for the upcoming meet" would be scored in two categories. Beside each checkmark, write the response number that corresponds to each rationale.

1) Don't know or doesn't answer question (describes what they did; nonsense response)

2) Reaction to sensation or movement restricted (was really hurting; it felt bad; couldn't walk on knee anymore; not a feeling I like)

3) Did not want anyone to know s/he was hurt or embarrass self by not trying

4) Not serious or nothing can be done (just stiffness, know it's not an injury; Other gymnasts say it's okay; I've learned it's okay, you get to know your own body; there's nothing you can do for it)

5) Adult decision (coach put me off; coach said it was ok; coach told me to; mom told me to stop/go)

6) Adult can give help (the coach knows what to do; my dad can help)

7) Professional advice (went to Dr. so I would know what to do; physio said it was okay; Dr. said to)

8) Not an important meet or just a practice (upcoming meet had more priority than this one; just a practice)

9) Important meet (if quit in that kind of meet, there goes your season; it was an important meet)

10) Conditioning effect (builds muscles; to get stronger; have to be tired after conditioning or it's not worth it; can't work with lactic acid too long, or its not effective)

11) Desire compete, participate, win, or achieve goals (didn't want to miss last meet; cuz it's fun)

12) Part of sport (you always try to finish a meet; have to have a lot of pain in this sport)

13) Pressure from others (team needed me; felt pressured because my trip had been paid for)

14) Make a specific physical change (to stop the swelling; loosen muscle up; flush out lactic acid)

15) Reduce/Prevent further pain (the pain may go away faster; might hurt more; so it won't hurt)

16) Prevent further damage (so it heals better; so it doesn't get hurt again; don't want a long term injury; I could break it)

17) Save self for future (so I can compete later; further damage would wreck future practices; If I break it, I can't train)

18) Affecting performance negatively (some moves would be poor; I'd get marks deducted; wouldn't be helpful to team)

19) Emotional response/mental state (not in a good mood; I was mad; didn't feel like dealing with the pain that day; was in a really good mood and just didn't worry about it)

20) To determine severity of damage by self (I wanted to see if I could put enough weight on it to continue)

21) End of set or end of practice (It was the end of practice; It was my last rope climb)

3. What do you think happens/would happen to your (body part) if you keep doing gymnastics while you have that type of pain? Check all that apply:

1) Don't know or doesn't respond to question

2) Nothing happens to body (pain goes away; gets bruised and heals; damage is done, can't get worse)

3) Enhances performance (since I got over it (pain), it gave me a boost)

4) Achieve conditioning effect (body gets used to pain and can go a bit further the next time; muscles grow)

5) Body fatigues or exhausts (it gets tired; energy quits)

6) Pain intensifies or recurs (hurts again; it would get hurting more; pain won't go away)

- 7) **Damaged occurs or worsens** (may get an injury; injury gets worse; it swells up; tears more)
- 8) **Takes longer to heal** (it won't get better; it will stay that way)
- 9) **Interferes with performance** (disrupts competition; wouldn't be competitive; would do badly)

4. **Now, that type of pain we are talking about, what did it feel like?**
[Prompt]: Tell me one or two words that says/describes how it felt. Record response verbatim

Okay, we just talked about a type of pain that felt like (use athlete's words) and where you did (use athlete's words) because (use athlete's words). Now I'd like you to tell me about another type of pain you've had that felt different or you did something different for it.

QUESTIONS 2 THROUGH 5 ARE REPEATED UNTIL ATHLETE CAN IDENTIFY NO FURTHER TYPES OF PAIN.

5. **Okay (name), now I'm going to ask you some different kinds of questions. First of all, what is an injury? [Prompt]: What happens to the body when someone has an injury?** Check all categories; add a "P" if prompt is used.

- 1) **Don't know or doesn't respond to the question or gives nonsense response**
- 2) **Names a body part** (the muscle; the bone)
- 3) **Non-specific hurt, pain, fatigue, sensation** (you hurt yourself; it's pain; muscle gets tired; stinging)
- 4) **Specific type of identifiable damage** (blood goes out and there's a cut; you break something; it's bruised)
- 5) **General damage to the body** (when the body is damaged; damage to the interior body structure)
- 6) **Describes mechanism of pain sensation** (the hurt spot sends a message to the brain)
- 7) **Something that restricts activity** (when you're hurt and can't compete; when you have to take time off; causes pain and you can't do something)

6. **Suppose a gymnast twisted her/his ankle and it hurt. Why does she/he feel pain? [Prompt]: What's going on in her/his body that causes her/him to feel pain?** Check one only, if prompt is used, mark with a "P"

1) **Don't know or unresponsive to question or nonsense verbalization**

2) **Recounts cause of injury instead of cause of pain** (she twisted it; his foot got caught in the mat)

3) **Names a body part that is not directly involved in pain sensation** (the liver; the blood)

4) **General sensation or response by the body** (you feel it; you're sick; the stabbing; body knows what's happening)

5) **Physiological event that led to damage/pain** (muscles got pulled; it could be broken or swelling; it got bruised)

6) **Cognitive/affective causes** (you look and see blood or a bruise, then it hurts; it scared her; he expected it to hurt)

7) **Recognizes role of the brain or the nerves** (the nerves; a signal from the injured site goes up the nervous system; the brain tells you; a mental thing, everyone has different pain thresholds, so the brain tells them what they can handle)

8) **Integration of the nerves and the brain** (nerves send message to brain and the brain tells you)

7. **Pain can sometimes be bad, but what are some good things about pain? [Prompt for more responses]: What else is good about pain?. [Final prompt]: Does pain ever let you know that you've had a good practice? [If yes]: Tell me about that.** Check all that apply, and for responses given after the final prompt, add a "P."

1) **Don't know/does not respond/no value/pain is bad** (Can hope it goes away; If you hurt it's a bad practice)

2) **Aid to concentration or a motivator** (acts as a challenge to conquer it; makes me want to go harder)

3) **Signal of hard work** (tells me I'm working hard; I'm doing good work)

4) **Increases tolerance for physical/mental pain** (Get tougher, if you have a lot, the little ones don't hurt so much; learning to deal with physical pain helps you deal with other types of pain; if you get used to it, you can handle it in a competition)

5) Signals an improvement in physical condition either during practice or the day after (have to break certain limits to have a good practice)

6) Secondary gain (more attention from parents; don't have to go to school; can watch more TV; can get out of practice)

7) Account for poor performance (if you're not performing well can say it hurts)

8) Warning to stop or take some action (tells you where your limits are; let's you know something is wrong; can learn from it - if it hurts, don't do it again)

8. Have you ever said you had pain so that you didn't have to do something you didn't want to do? [If no]: Not at gymnastics or at home? [If yes]: Tell me about it. [If they mention one setting (e.g., sport) ask if they've ever done it at home. Check all that apply:

1) Don't know or doesn't respond or nonsense answer

2) No without elaboration

3) No because of commitment to sport (No, I know what it takes to do my best)

4) Used sport-related pain for secondary gain at home, school, work, or another sport (left job early; didn't have to do dishes; didn't have to play with friends; didn't have to do basketball)

5) Used sport-related pain for secondary gain at gymnastics (said my rip was too bad to train; said my shoulder hurt too much to do weights)

6) Used non-sport pain for secondary gain at home, school (headache to get out of doing dishes)

7) Used non-sport pain for secondary gain at gymnastics (said I had a stomachache so I didn't have to train)

8) Scared of something in sport (If I'm scared of a move I'll say my knee hurts too much)

9) Account for poor gymnastics performance (If I have a bad day I'll say it's because of my shoulder)

10) Yes, but it didn't work

Appendix D - Athletic Pain Questionnaire (APQ)

Questions 1 to 6 are completed by athlete. Read questions 7-17 to athlete and parent and record responses. Substitute "hurt" for "pain" when necessary.

1. Think of the *most pain you have ever felt*. Rate how it felt on the scale below.

no pain

 worst possible pain

When did this happen? _____

What happened? _____

2. How *often* do you feel pain during *practice*?

never

 every practice

3. Think of the *amount of pain you usually feel* during a practice. Rate it on the scale below.

no pain

 worst possible pain

4. How *often* do you feel pain during a *competition*?

never

 every competition

5. Think of the *amount of pain you usually feel* during a *competition*. Rate it on the scale below.

no pain

 worst possible pain

6. How important is your sport to you?



7. How many injuries have you had from gymnastics in the past 12 months?
8. How many injuries have you had that have kept you out of a practice or meet?

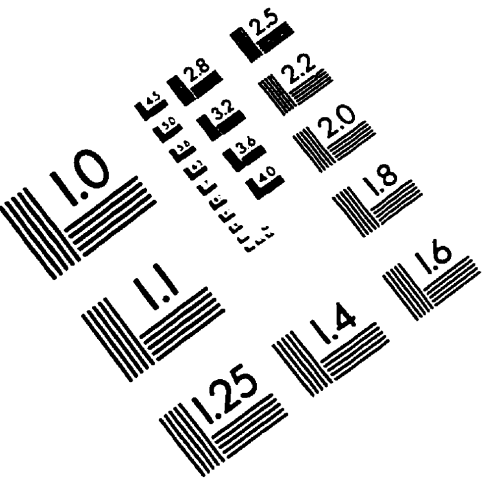
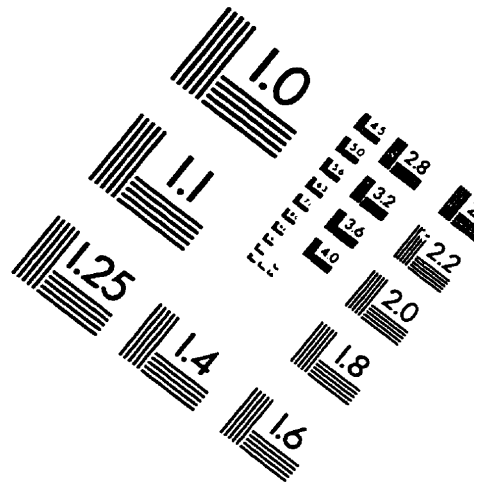
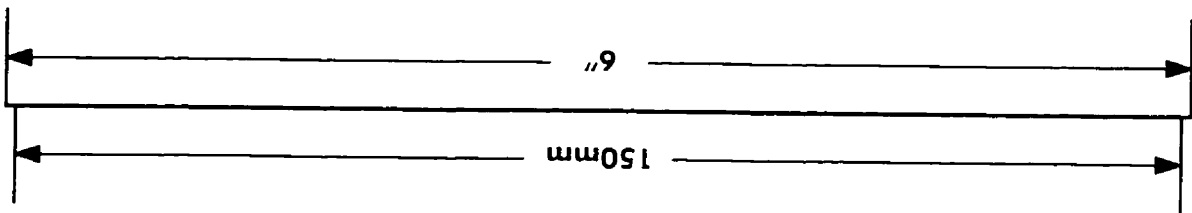
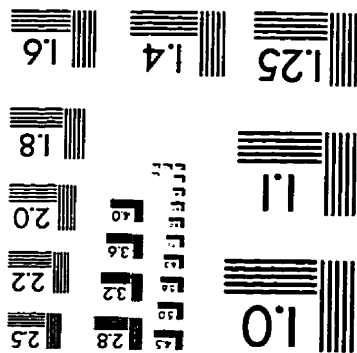
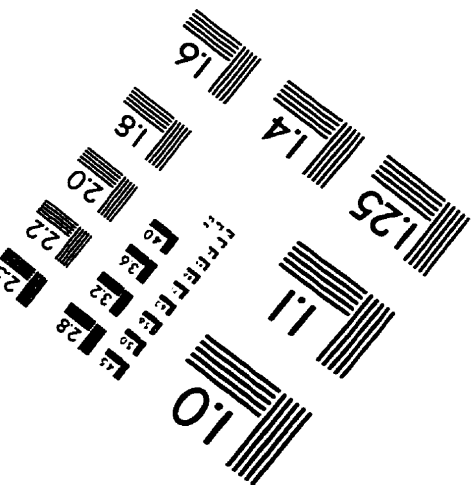
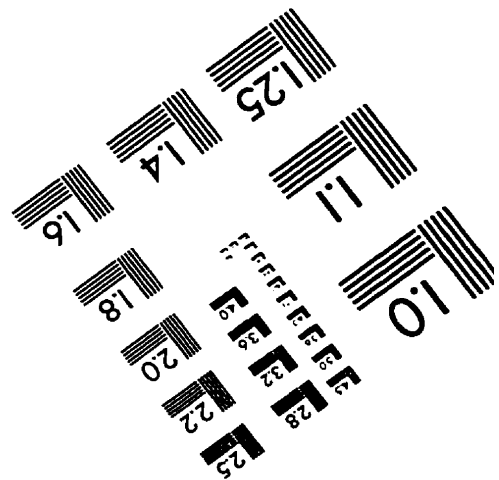
(If necessary, ask for typical number per season and multiply by # of seasons).
9. Have you ever been to a physiotherapist or other health care professional because of an injury (not just from sport)? How many times have you gone?
10. How many hours per week do you practice gymnastics?
11. How many competitions have you been in in the past 12 months?
12. What other organized sports have you participated in in the past 12 months?
How many hours per week were you involved in that/those sport(s)?
- | <u>Sports</u> | <u>Hours per week</u> | <u>Months per year</u> |
|---------------|-----------------------|------------------------|
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Total hours in other sports in past 12 months: _____

13. How old were you when you first became involved in organized sport? (Not just gymnastics, but any sport).

Current age - age started sport = ____years in sport

IMAGE EVALUATION TEST TARGET (QA-3)



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